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PUTTING GREEN SAND TO WORK
HOW MUCH AIR FOR THE TUNNEL?

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS

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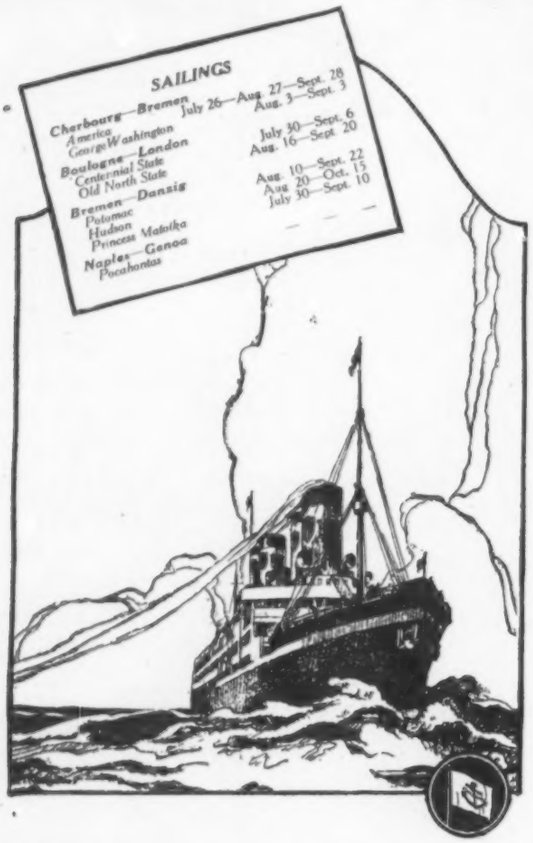

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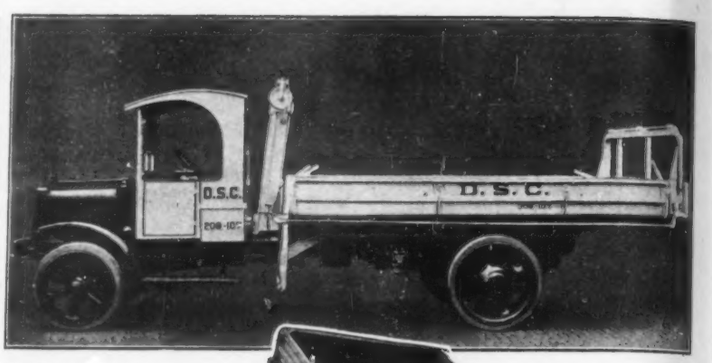

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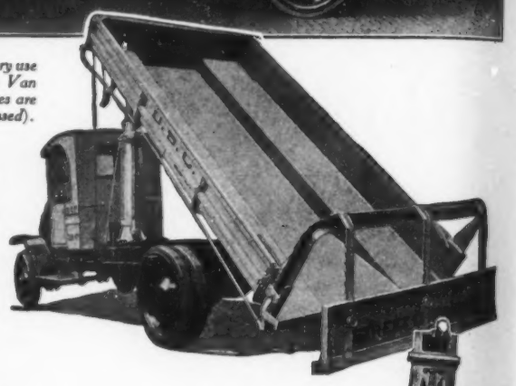

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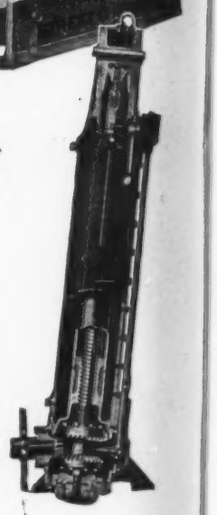

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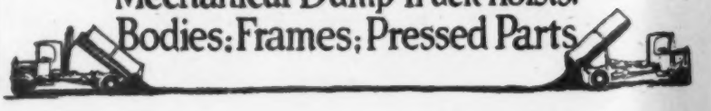

SEVENTY-SEVENTH YEAR

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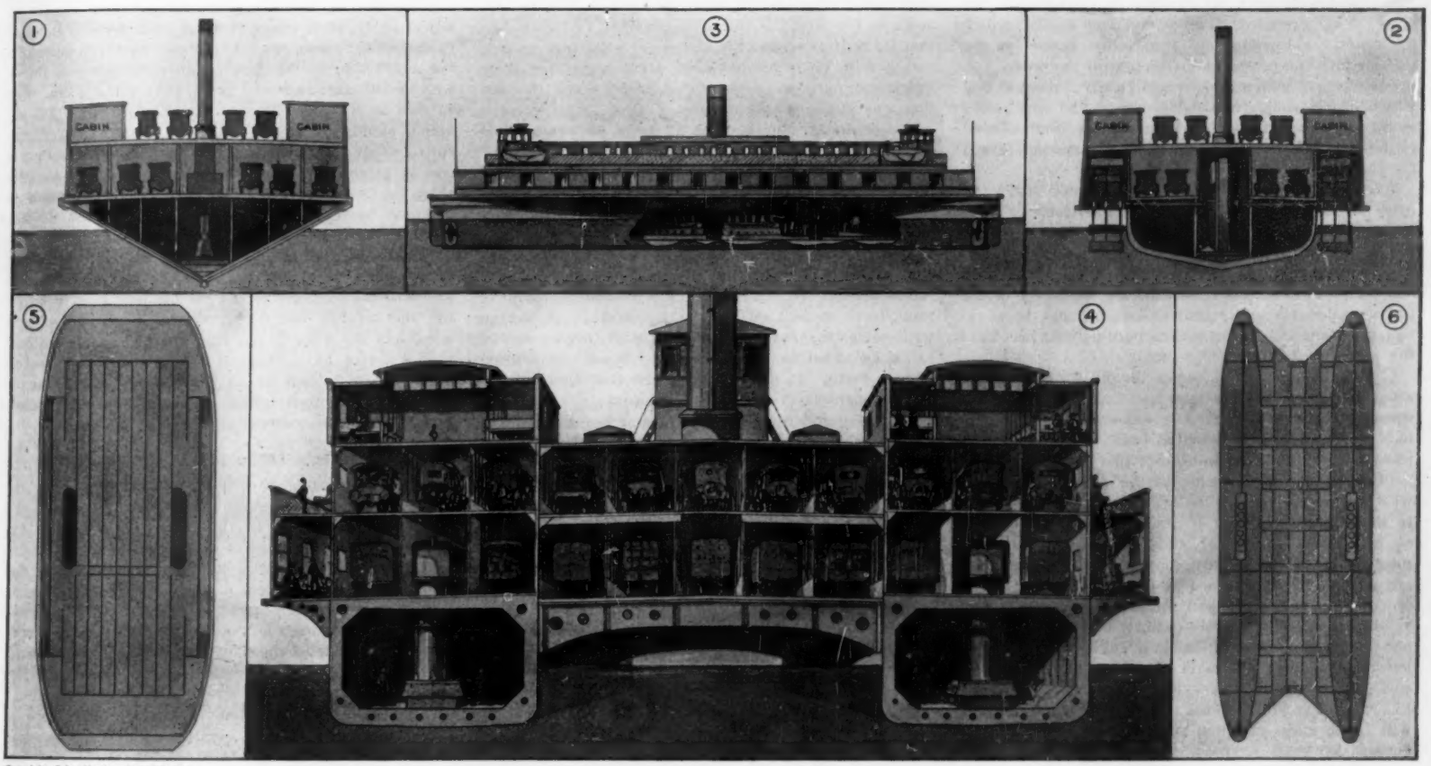

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1. Two-deck automobile ferry with oil-electric drive. 2. Two-deck automobile side-wheel ferry with oil-electric drive. 3. Single-deck automobile ferry with oil-electric drive. 4. Twin-hull or catamaran ferry with Diesel-engine drive. 5. Main deck of catamaran boat, showing gangways for automotive vehicles. 6. Plan view of catamaran hulls with their interconnecting girders and longitudinals

Features of some of the remarkable ferry boats that are proposed for the handling of our heavy vehicular traffic

Something New in Ferries

By Robert G. Skerrett

A NUMBER of our big and most industrious cities are so located that rivers, bays, etc., necessitate the operating of ferry lines for the convenience both of passenger and vehicular traffic; and with few exceptions the boats are of types which have been built primarily for the accommodation of passengers with some space reserved on a single deck for the transport of vehicles of divers kinds. In consequence, during rush-hour periods, it is no uncommon sight to see scores of horse-drawn and power-driven conveyances lined up awaiting their turns to get aboard the inadequate ferries. The congestion is inevitably intensified by the speed of the motor truck and the automobile which brings them to the focal point, while the slow-moving vessels, with their intermittent schedules, strangle or bottle-neck the traffic tide. A staggering amount of time is thus wasted going to and fro; and it is probably no exaggeration to say that many millions of dollars are thus squandered in unproductive hours in the course of a twelvemonth. This is certainly the case in the Port of New York, where numerous ferry lines are indispensable.

For some years it has been evident to students of the subject that vehicular traffic needs could be met only by the construction of craft especially designed for the carrying principally of self-powered conveyances—the accommodation of passengers, *per se*, to be a secondary matter. It is interesting to note that Westerners have been foremost in this department of naval architecture; and plans have recently been developed looking to the creation of a flotilla of double-deck ferries for the handling of automobiles and motor trucks across the waters contiguous to San Francisco, the idea being to carry the vehicles on both the main and the upper decks to San Francisco. One route is between San Francisco and Oakland, on opposite shores of San Francisco Bay, and another run is athwart the Golden Gate, linking San Francisco with Sausalito in Marin County, to the north.

Ferries of this nature would, of course, require modifications of the terminal facilities. That is to say, it would be necessary to build an inclined runway or ramp leading to and from the level of the upper deck of the boats, and, in addition, there may have to be provided adjustable aprons or platforms for both the upper and lower decks in order to take care of tidal differences. There are no engineering difficulties of moment involved in these associate features, and the expense entailed would soon be covered by the increased revenue made possible through the amplified capacity of the vessels.

The Western marine engineers and naval architects have shown considerable ingenuity in their designs, and they have sought to avail themselves of typically modern propelling plants for their boats. That is to say, they are convinced that the ends of economy can be best served by dispensing with the steam engine and substituting in its stead prime movers of the heavy-oil Diesel pattern. Messrs. D. W. Dickie and R. Z. Dickie have drawn up plans for side-wheel and screw-driven ferries to be operated by oil-electric power. Mr. Jonas F. C. vonRosen, on the other hand, has placed his dependence upon Diesel engines alone.

It might seem something like an anachronism to retain side wheels in combination with an oil-electric drive, especially when it is borne in mind that paddle wheels are relatively slow-moving propulsive agencies while the electric motor is most efficient when revolving rapidly. True, the difference could be harmonized by recourse to a reduction gear, but this invites a mechanical complication scarcely warranted in ferry service. The Messrs. Dickie have solved their technical problem by connecting the paddle-wheel shaft directly with a single large motor of such size that the linear angular speed of the machine will be identical with that of a much smaller motor making a greater number of revolutions a minute. One of the drawings accompanying this article illustrates the magnitude of the proposed motor. Therefore, the big and comparatively slow-turning motor can be depended upon to work efficiently and economically.

Current to energize the motor will be generated by two 500-horsepower, 8-cylinder Diesel engines of the non-reversible type, each of which is to be coupled to a dynamo. Both dynamos will furnish electricity to the paddle-wheel motor, and so long as one of the Diesel

(*Continued on page 52*)

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The President's Great Opportunity

SELDOM, if ever, in history has one man been presented with so sublime an opportunity for doing a work both great and good as that which confronts the President of the United States at the present momentous era in the history of the world.

We refer, of course, to the practically universal call which has gone up from a war-weary and war-hating world for our President to convene an international conference for the reduction of naval armaments and the prevention of future naval rivalry.

It took a world war to drive into men's heads the utter stupidity of settling debated questions by war. Whatever the war has left behind, it has certainly rooted that conviction in men's minds; and it is there to stay for a long time to come. Why so? For the very simple reason that a war of nations, where the whole national strength and resources are engaged, is so exhausting that the victor suffers only a little less than the vanquished.

If this be so, whence comes the flood of literature attempting to prove that the nations are looking forward to the "next war?" It comes largely from interested people—from defeated enemies and from professional writers who want to make "copy," whether in dailies, in magazines or in the printed book, and who are searching for the sensational. They find it in this damnable lie as to the inevitable permanence of war. For the writer must write, and the press room is clamoring for its copy. Finally, the permanence of war is proclaimed by those ghouls who fatten on the preparation for and the practise of war. And, by the way, as far as this country is concerned, these last-named are building upon a false hope; for the President it was who said that should another war come, everything and everybody would be conscripted, labor equally with capital. Which means that there will be no more cost-plus and no more ten to fifteen-dollar-a-day wage.

Do the people of the world want any more war? They do not; certainly not in a national sense. In spite of sporadic outbursts here and there, the nations as nations are saying in their heart of hearts that they hate war, and if they can only see the way, will make an end of it altogether. Publicly their statesmen are saying the same thing in unmistakable terms.

So the world has turned to us as the nation which, by virtue of its wealth in men and natural resources, is best able to carry on war, and has frankly asked us to take the initiative for peace. The people of this country have risen to that cry and have answered that they are for peace and for a reasonable reduction of armaments. More than that, both Houses of Congress have voiced this call of the people in a joint resolution, in which the President is asked to call a conference of the three great naval powers to discuss the question of reducing naval armaments.

We do not hesitate to repeat that never in the history of this republic has a President been confronted with a finer opportunity to do a great work for the healing and uplifting of a sorely troubled world. If the President should send out the call for such a conference tomorrow, he would do it with the knowledge that not only the people of America but the citizens of the world at large are behind him; and any thoughtful student of the course of international affairs during the past few months, and particularly in the past few weeks, will feel justified in regarding the outcome of that conference with the most confident optimism.

In a very real sense and in perfect accordance with history, it can be said that the story of the growth of civilization is a story of the substitution of reason for force; the substitution of the policeman for the soldier; the substitution of the judge for the general, and of the quiet, reasoned utterances of the courtroom for the clash and clamor of the bloody field of battle.

All these changes we have learned to make as between man and man, city and city, county and county, state and state. Today, the world is asking itself whether it has the courage and the self-denial to carry the emancipation from war one step further by setting up an international court and pledging itself to abide loyally by its decisions.

Tremendous

WE live in a hectic age. The fever shows itself in diverse directions, and nowhere more than in the written and spoken word. Our forefathers were better balanced, and it can be put down to the credit of the much-despised Victorian Age that its writers were at least moderate in their speech, and had a Victorian habit of using words for their legitimate purpose of conveying exactly the thought that was in the speaker's mind.

Not so today; for we are all more or less victims of the germ of what we might call "superlativitis." Take literature, for instance. We find that most of the mediocre writers, and not a few of those who have claims to distinction, seem to have abandoned the positive degree, look askance upon the comparative, and are only at their best—or worst—when they revel in superlatives. Things that used to be big are now "tremendous." Things that a mid-Victorian would have pronounced to be good are today "superb." A woman with some pretense to good looks who then would be called beautiful has now become a "dream"; and so on and so forth. It may be answered that this is none of the business of a technical journal; nor would it be if the pestiferous little germ had not entered the sacred fields of science—an invasion which is perilous for scientific accuracy and positively exasperating to the scientific mind.

Having thus delivered himself in the general, the editor now wishes to speak in the particular by directing the attention of SCIENTIFIC AMERICAN readers to the positive craze, which, seems to have overtaken not a few technical writers, for using that much-abused word "tremendous" in all sorts of connections in which it should never be found, and where it would be quite easy to substitute some old-fashioned Victorian adjective which would exactly express the truth. Whence comes this habit of exaggeration? If our beloved Mark Twain were alive today he might say that since "all men are liars," a listener, in the endeavor to get at the truth of a statement, puts a discount of 50 per cent on what he hears, and a speaker, if he wants to get his meaning into another man's mind, must overstate his case about 100 per cent. Be the explanation what it may, there is a deplorable tendency to adjectival exaggeration, of which the misuse of the word tremendous is just now the most glaring example.

Now the dictionary defines tremendous as follows: "such as may or does excite trembling, fear or awe; overpowering in character or quality; awful; dreadful: as a tremendous explosion, tremendous invective." By way of illustration, the dictionary quotes Macaulay as follows: "The battle of Ravenna, one of those tremendous days into which human folly and wickedness compress the whole devastation of a famine or a plague."

Now, the desire on the part of the scribe to put "snap" or "ginger" or "pep," if you will, into his writing, even if the subject be a serious scientific or technical one, is perfectly proper; but he should never try for this result by meretricious or misleading means. For instance, if a sudden freshening of the breeze raises the speed of the Cup defender, "Resolute," from ten to, say, twelve knots, it is perfectly proper to speak of her showing a fine burst of speed; but it is ridiculous to say that she showed a tremendous burst of speed. If a yacht designed to make twelve knots on a reach in a fairly smooth sea succeeds in doing that, there is nothing tremendous about the exploit. The San Francisco earthquake was tremendous; tremendous was that blast of hot gases which swept out from the ruptured peak of Mount Pelee, and in a moment wiped 30,000 men, women and children off the face of the earth. The World War, with its loss of ten million lives and 200 billions of wealth, was tremendous. Indeed, the only thing tremendous about this widespread misuse of a great adjective is the tremendous scale upon which the folly is being perpetrated. For the vice is spreading, and we have been amazed to find how greatly the abuse of this word is marring the work of some of our best contemporary writers.

By all the rights of the thing, when a man sits down to breakfast and announces that he has a tremendous appetite, there should be a sudden flight from the table; for to do justice to the term he should not only eat his own breakfast, but make short work of father, mother and the whole family group. That would be a tremendous appetite!

And, gentle reader, do not come back at the editor and say that he is pushing the thing too far; that the adjective in such cases is used in a hyperbolic and exaggerated sense, as everybody well understands. We admit that in this last example the point is fairly well made. But so is our point, that when a language so rich in its vocabulary as the English, provides an ample supply of words that will exactly and truthfully convey the intended meaning, it is a vicious practise to reach out for words which express much more than the speaker really intends. If an invention is destined to take a useful place in the arts, do not speak of it as having tremendous importance in those arts. If you wish to point out that a certain structure is not quite as strong as might be desirable, do not say that the designer took a tremendous risk in building the way he did. Furthermore, it is a complete misuse of the word to say that so and so, or such and such a device, has a tremendous opportunity for usefulness. There is nothing to "excite trembling, fear or awe" in the contemplation of widely-extended usefulness. Quite the contrary.

The State's Duty to Its Barge Canal

THE State of New York has built a very fine barge canal between the Great Lakes and the Atlantic Sea. In this great effort it has expended over 160 millions of dollars of the State funds; and there, unfortunately, it seems content to let the matter rest. Consequently, the barge canal is doing only a small fraction of the carrying trade of which it is capable. Not only is the canal able to carry a very large percentage of the total freight which moves from the Great Lakes to the coast, but it can carry this freight at materially lower cost. Proof of this is found in the fact that the General Electric Company at Schenectady has built its own barges and by means of these it is shipping freight at a cost 20 per cent less than it can ship it by rail.

It must seem strange to thinking people that in these days when every one is endeavoring to cut down costs of production and of delivery to the consumer, a waterway like this, capable of carrying freight cheaper than the railways, should be doing so little work. The reason is to be found in the fact that during the period of many years covered by the construction of the canal, there was but one way for the manufacturer and the farmer to ship their goods, and that was by rail. Consequently, the people have got into the habit of thinking and figuring in terms of the cost of rail transportation. They have yet to be taught to think in terms of canal transportation. In other words, there is need for a good old-fashioned campaign of advertisement, in which the shipping public must have put before them the capacity of the canal and the fact that it can carry freight from the Lakes to the New York terminals, not only cheaper than railroads, but on an average, in equal time. These facts should be made known through the press and in that varied and very effective form of pamphleteering which has been developed into an art by the modern advertising expert.

And this work of advertising the canal should be done by the State itself; for this is a State work, built for the development of the State, which lacks today only the thorough-going backing of the State in the way we have indicated to make the enterprise the success which it deserves to be and, we firmly believe, will prove to be, if the State will lend its influence to a legitimate, well-thought-out and persistent educative propaganda.

Electricity

Hydroelectric Plants for Japan.—It is understood, states an issue of *Finance and Commerce*, that a plan for the construction of nine hydroelectric plants to use the waters of the Sho and the Chigusa Rivers is being considered by the Hyogo Prefectural Assembly. It is proposed to begin construction in 1921 and to complete three plants every two years until 1926.

New Type of High Resistance.—In a recent issue of *Zeitschrift für Technische Physik* there is a description of a new type of high resistance. The resistance consists of a thin layer of graphite wound round a glass spiral. A convenient way of mounting it is to attach it to the stem of an ordinary electric bulb which is filled with hydrogen to facilitate the conduction of heat. Sample resistances, varying from about 3×10^8 to 3×10^9 ohms, have been tested and found to be very constant. They are capable of taking up to 1 watt per square centimeter of graphite surface for continuous loads.

Automatic Converter Stations.—A recent article describes in detail the Brown Boveri system of automatic single-armature converter stations. Such automatic stations seem destined to play an important role in future conversion and distribution work, as by installing separate converter stations close to the main feed points, great saving can be effected in conductors, voltage regulators, etc., and with automatic stations no permanent staff is needed. Starting, stopping, restarting after interruptions, alarms and permanent disconnection in case of uncleared faults, are all carried out by means of a combination of time switches, relays, contacts and distance controls.

Experiments on Residual Charge. — Investigations of residual electrical bi-refringence having led to the observation of a residual charge in condensers in a spark circuit, an experiment was undertaken to show the residual charge of dielectrics, particularly glass. The experiment, continues *Revue Generale de l'Electricite*, was carried out with a Leyden jar, charged by a small Ruhmkorff coil across a point-disk gap. A water rheostat and a Geissler tube were shunted across the condenser. The coil circuit was momentarily closed, a spark obtained across the tube. After the circuit was opened, a series of residual sparks could be observed in the dark, occurring at increasing intervals of time. The number and spacing of the sparks depend on the resistance.

The Storage Battery at Its Best.—It is remarkable that storage batteries can be used and abused on automobiles in the way they are in every-day practice. Years ago it would have meant a very short life for any storage battery submitted to the gruelling service of automobile starting and lighting. Every time the engine is started on the average automobile, anywhere from 30 to 80 amperes is drawn from the storage battery—a very heavy drain, to be sure. Often, too, automobile storage batteries are discharged considerably below the safe point, yet these batteries somehow hold out. Also, they are often overcharged for long periods without immediate harm. The wonder of it all is that the average storage battery gives such long service under the circumstances.

Electrical Analysis of Aluminum Ore.—An important discovery, a new method of extracting aluminum from a certain mineral, which affects the future development of Japanese industry and the formulation of an established air policy of the Japanese Government, is the result of the investigations which have been carried out by the experiment station on the production of aluminum and its compounds. A great refinery plant driven by electric power is to be established at Yoyogy. A project is under contemplation to establish a semi-governmental company for the manufacture of aluminum by the new method, which consists in the electrical analysis of ore by Korean alum and other materials and enables the production of more than 99 per cent of aluminum.

Pintsch Lamp for Switch Circuits.—If two metallic electrodes are introduced into a glass bulb containing a rarefied atmosphere of neon or helium and a direct-current voltage of at least 160 volts is impressed upon the two electrodes, the negative pole will emit a distinctly visible light, which at about 220 volts becomes so bright that such a lamp may be used advantageously for signal purposes on switches and similar apparatus. On alternating current both electrodes show the light emission. A great variety of such lamps were recently introduced by the Julius Pintsch Company of Berlin. Parallel with a fuse, such lamps detect and show a burn-out. They will serve as a position indicator for switches or as a distant indicator of the condition of a motor. These lamps have many different applications other than those already mentioned.

Science

Lo the "Poor" Indian.—Owing to the sale of valuable oil lands in Oklahoma approximately 2,000 members of the Osage tribe will receive an annual income of $10,000, and the Osage Indians become the richest people in the world per capita.

Best Wire for Pictures.—They have recently been experimenting in England on the best support for pictures and it was found that plain copper wire in one strand is far superior to twisted brass wire, and copper wire is, of course, not liable to rust.

A Bird Sanctuary for Gulls. — Natural history has many students in Canada proper and the provinces. The town of Yarmouth, Nova Scotia, has recently purchased an island in its local Lake George as a bird sanctuary for great black-backed gulls.

German Emergency Cook Book.—One Magda Trott has written a cook book giving recipes for substitutes for food or food substitutes used during the emergency that followed the outbreak of the late war. It is called "Kochbuch mit 600 Kochvorschriften aus Knappen Tagen."

The Purification of Olive Oil.—The disagreeable bitter taste acquired by olive oil is due, probably, to the decomposition of albumoid substances. By heating the oil to 100 degrees Cent., these latter substances will be coagulated and may then be readily removed. In order to remove the free acid fats it suffices to agitate or shake up the oil with lime water.

Popularizing Mathematics.—At the summer session at Columbia University an attempt will be made to show teachers how to make the study of mathematics attractive. If the same effort had been made years ago to popularize mathematics as was expended on chemistry we would have more people with a mental background capable of understanding Einstein, which is by the bye to be included in Columbia for the first time in a college curriculum.

Greek Art for Poor Children.—To impress the value of the classics on young and poor children the University Settlement House at Beacon, N. Y., has erected a mansion whose porticos are representations of the Parthenon and the Erechthium at Athens. One façade is built on the Ionic order and the other the Doric order. So now the beauty-starved boys and girls from New York's great East Side can play and live under the shadow of the great examples of Greek architecture —even if they are executed in pine.

Three Killed by Radium's Effect. — The death of three persons connected with the Radium Institute, which at first was declared to be directly caused by their proximity to the radium, has been found to be only indirectly the result of their work. An investigation recently completed showed that while the three victims died from ordinary disease, it was their power of resistance that had been undermined by their work with radium. Every member of the Radium Institute was affected by the presence of the radium. Each of the three who died was suffering from anaemia when attacked by other diseases and therefore they were in no condition to resist the illness.

The Oldest Auto Still Running.—Paris is used to unusual sights, and a few days ago the populace was treated to the sight of the venerable great-grandfather of the automobile. The owner, the Abbé Gavois, who was perhaps the first professional man to recognize the value of the automobile for getting around the country for pastoral or other duties, managed the creaking old contraption. He was greeted with salutes of horns throughout his progress through the city. The long-visioned Abbé is looking to sell the historical machine and the proceeds will help the poorer clergy of his district. The "car" has not been overhauled in thirty years and barring a touch of asthma is still runable.

Sweet Potatoes for the Candy Manufacturer.—By a roundabout process the sweet potato is to be turned into an important raw material for the candy maker. The succulent southern tuber is, of course, first turned into syrup and the candy follows in due course; for, contrary to the usual belief, not all candy is made from sugar, syrups forming an appreciable part of the supplies. The increased use of the sweet potato will be a boon to the not too prosperous Southern farmer as it will enable him to diversify and rotate his crops, and if the cotton or tobacco crop is bad will tend to equalize the losses, for sweet potatoes are easily grown. The molasses factory will take the "sweets" and turn them into syrup, giving the farmer a much higher profit from his crop. The factories will be located in sections where the sweet potato is most easily grown, and this will give the farmers of those sections a new line of profitable agricultural endeavor.

Astronomy

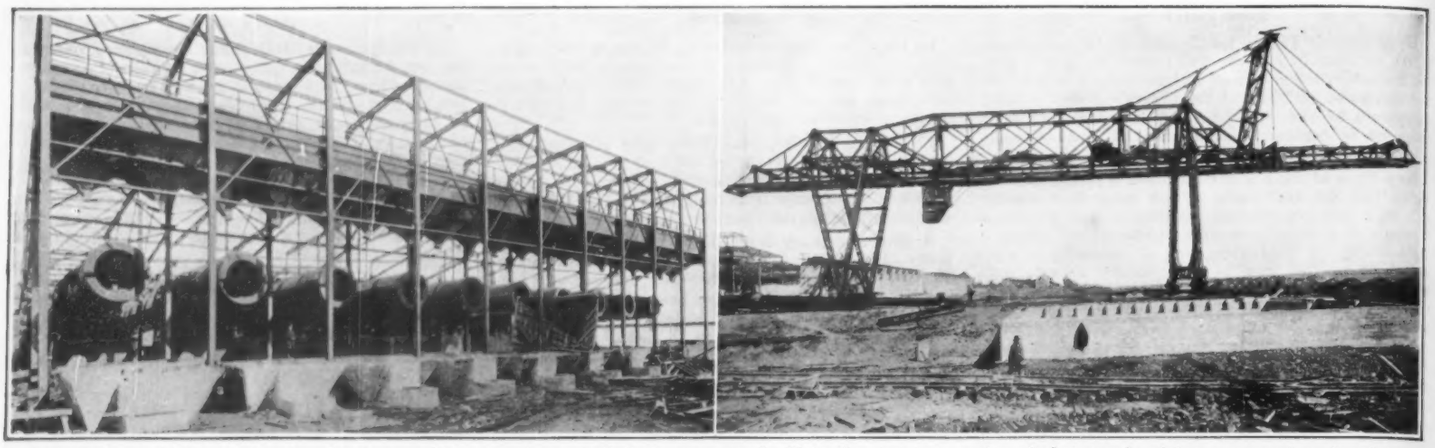
An Exceptionally High Solar Prominence, observed October 8, 1920, was described at the last meeting of the American Astronomical Society by Mr. Oliver J. Lee, who presented the results obtained from a study of 57 photographs taken of this eruption. The crest attained the remarkable altitude of 531,000 kilometers. The highest velocity observed was 155 kilometers per second. The photographs reveal many peculiarities of motion. The head of the prominence separated into parts, which continued the upward course unchecked, while other parts reversed their motion and fell back upon the sun.

Observation of the Gegenschein in London.—In the memoirs of the British Astronomical Association it is recorded that Dr. W. H. Steavenson saw the gegenschein from his garden in Norwood on the night of Feb. 5, 1916. He describes it as not quite half as bright as the Milky Way in Monoceros. It was oval, about 8 by 15 degrees, with long axis parallel to the ecliptic. So far as known, this is the first time the faint object in question has ever been seen from a London suburb, and the observation was possible only owing to the lights of London being extinguished for military reasons.

Extension of the North America Nebula.—A photograph of the region including the well-known North America nebula, taken by F. Henroteau at the Dominion Observatory, shows a very large extension of this nebula, covering an area of 10.5 square degrees, as compared with 1.6 square degrees, the area of the North America nebula proper. The photograph was taken Oct. 10, 1920, with an exposure of 3 hours. The great transparency of the sky at the time of exposure and perhaps a greater sensitiveness of the plate for light of favorable regions of the spectrum, are responsible for the detection of the larger nebula.

A Defect in Astronomical Photographs.—In measuring the distance between neighboring star images and spectral lines on the photographic plate some account must be taken of the tendency of the photographic process to make these images approach or recede from each other, in consequence of turbidity, gelatin disturbance, developer action, etc. Mr. Frank E. Ross has recently reviewed the literature of this subject and reported the results of his own experiments on the behavior of artificial double stars, close bright lines and close absorption lines. He finds that important differences develop depending upon whether the exposures are normal or overexposed. The contradictory results obtained by various investigators are thus explained. With overexposure, strong repulsions of neighboring images are found, except in the case of absorption lines, in which a strong attraction is found. In the case of normal exposures, an attraction between the images is usually found, amounting to two or three microns. In order to reduce this effect, the exposure should be reduced to a minimum. In the case of overexposures, considerable variation in the repulsive action was found by varying the developer. A further study of developers is desirable in this connection.

Recent Observations of Well-Known Novæ. — Most of the new stars that have appeared in past years are still visible with large telescopes, and the study of these stars in their fainter stages has been for some years a part of the program of the 40-inch Lowell reflector Mr. C. O. Lampland has recently published a summary of these observations, carrying the history of the novæ down to the latter part of the year 1920. The magnitudes given in the following extract are photographic. *Nova (Q) Cygni, 1876.* Only small variations of light noted on the photographs; present magnitude about 15. *Nova (T) Aurigæ, 1891.* Light nearly constant in recent years; magnitude now about 14.7. *Nova Persei, 1901.* This nova has undergone marked fluctuations of brightness between Feb., 1917, and Dec., 1920, the observed range being about two magnitudes (13-15, approximately). The wisp of nebulosity near the nova discovered by Barnard in 1916 has been photographed frequently at Lowell Observatory. The nebulosity is moving away from the star at the rate of a quarter of a second of arc a year, or a little more, its form has changed slightly, and there is an appreciable increase in its width. *Nova Geminorum 1, 1903.* This star is gradually and slowly falling off in light and is now fainter than magnitude 16. *Nova Lacertæ, 1910.* Quite constant in recent years; magnitude now about 14.5 *Nova Geminorum 2, 1912.* Small fluctuations have been noted, but the light is gradually becoming fainter; present magnitude about 13.5. *Nova Monocerotis, 1918.* In March, 1918, it was near magnitude 10; in November, 1920, it was a little fainter than magnitude 15.



Left: **Battery of kilns for burning the lime used in extracting potash from green sand. Note the man near center of photograph, giving a comparison for size.**
Right: **Giant crane employed for many purposes at the New Brunswick green sand reduction plant**

Putting Green Sand to Work

How the Hitherto Untouched Glauconite Deposits Will Insure Our Future Potash Requirements

By R. Norris Shreve

FROM the neighborhood of Atlantic Highlands, New Jersey, as far down our east coast as Virginia, in several places crossing the shore line, are found vast deposits of a dark material called green sand. There are millions and millions of tons of this substance in the state of New Jersey alone, and while the farmers did once upon a time use it as a fertilizer, they abandoned it fifty years ago; in truth, until quite recently it has not been regarded as of any more, if even as much, value as the ordinary sand of the seashore. The only marketable use for it was to put it in small vials and sell it to the customers of the curio shops at the Jersey seaside resorts, and such sales were not numerous enough to exhaust the deposits in several million years. So it was a drug on the market.

But within recent years this curious dark green mysterious sand has assumed a real importance, as it has been found that it can be made of great value to farmers. If this had been known before the war, the difficulty experienced by our farmers in producing their crops when the German potash supply was shut off, would never have been encountered; for it has been determined that this green sand contains enough potash to supply every need of the American farmers for the next thousand years.

Here is a touch of romance! While our agriculturists' principal cry has been for more potash so that the globe can be made richer, our crops be more abundant and the cost of living lower, and while Germany, to meet this demand, has been selling thousands and thousands of tons of this substance to this country, at our very door all the potash we could possibly use and much more has been lying idle.

The story of this green sand sounds like an Arabian Nights's tale. Ages and ages ago the deposits were built up slowly underneath the waters of the sea, the process continuing for millions of years. Gradually, as the ocean receded, they emerged from beneath the waters and became dry land, and there again they lay slumbering for ages undisturbed and almost unknown, until they suddenly emerge as a veritable gold mine for economic productivity and a real boon to the American farmer.

While, as previously stated, the great belt of green sand extends from the neighborhood of Atlantic Highlands, New Jersey, far down into Virginia, and is easily reached from the surface, it is in New Jersey that most of it is found. Enterprising men, realizing the possibilities of green sand, are buillding a large factory at New Brunswick, N. J.

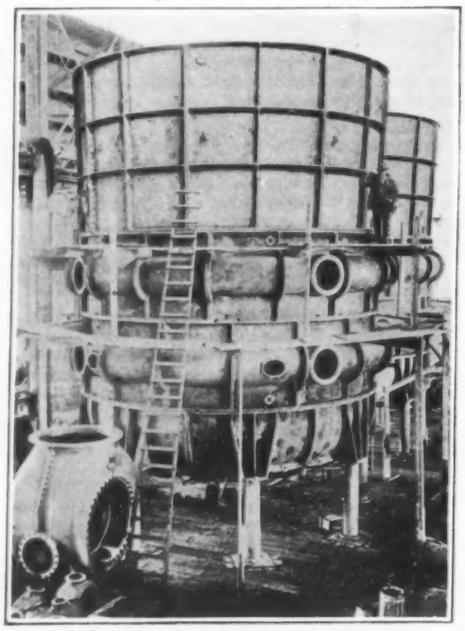
Besides the purest potash—one of the three constituents of fertilizers—the experiments have revealed that the green sand can also be made into the finest brick, and the plant where the green sand will be handled actually has been built of this brick.

As the most promising source of potash in the eastern section of the United States, the green sand deposits came in the nick of time to fill the crying need for the development of our own fertilizer industry. The war had completely cut off America's chief source of supply, Germany; and we were in serious danger, agriculturally speaking, until the happy thought of three men, who invented a process for utilizing the green sand which makes this country's potential potash supply staggering in proportion.

The United States uses 250,000 tons of potash a year, and the United States Geological Survey has estimated that a square mile of green sand one foot thick will yield 78,000 tons of potash. A twenty-foot bed that covers a square mile should yield 1,500,000 tons of potash, or enough to last the entire country for about six years.

During the period when the green sand was formed a great number of prehistoric animals inhabited the earth and sea, and the remains of these animals occur in the material which is now being made into potash. Indeed, one authority says that the sand is nothing more than accretions or deposits that were built up during the decay of countless billions upon billions of microscopic animals, which, as they died, fixed the potash for a future age to use. Skeletons of numerous reptiles, together with fossil shells and the remains of the microscopic animals, give the searcher of today a picture of the teeming life of those past ages.

After the death of the minute organisms, their shells were slowly filled with the fine potash-bearing mud in which they were deposited. The potash from the mud and the sea water accumulated in the shells which finally disintegrated and became decomposed until the phenomenon of green sand appeared, which eventually was raised up from the sea bottom to dry land, forming what is mineralogically called green sand, or glauconite.



One of the four giant three-story evaporators to be used in the concentration of potash extracted from green sand

A steam shovel of the type that will be employed in mining the green sand deposits

The discovery of the commercial value of the green sand came about in this way. During the war search was made everywhere for potash-bearing minerals, and T. C. Meadows, an experienced fertilizer chemist, knowing of the old but long-abandoned potash fertilizing value of the green sands, decided to see what the skill of the chemist could do toward unraveling the wealth of potash stored up for so many ages. Samples of green sand were obtained and were subjected to chemical processes by Mr. Meadows and his associate chemist, Mr. H. W. Charlton, and they found that it worked splendidly—very much better, indeed, than the other minerals that they had tried. They realized that their search was ended. The problem then became one of inventing a process for releasing the potash. This was evolved after considerable experimentation at a small plant at Jones Point, New York, where a third chemist, the writer, was called in to assist them. There the problem in all its phases was considered.

(*Continued on page 52*)

Our Latest Battleship, the "Maryland"

By C. D. Wagoner

WHEN the super-dreadnaught, the U. S. S. "Maryland," steams out of Hampton Roads, early in November and points her clipper bow toward the sea for her official government trials, the nation will hail a new pride of the Navy and the Navy itself will acknowledge a new Queen of the Seas.

The "Maryland" is in every respect the latest completed achievement of American naval architects. Carrying eight 16-inch guns, the largest ever mounted in a battleship, she will be the most powerful fighting vessel in the world. These mammoth guns, located in four turrets of two guns each, fire a shell weighing 2,100 pounds for an extreme distance of more than 20 miles. The guns are over 60 feet in length and for each full charge approximately 480 pounds of powder are required.

The secondary battery, consisting of fourteen 5-inch guns, is carried for use against torpedo boats, submarines and other smaller craft. The ship has also four 3-inch anti-aircraft guns, a 3-inch landing gun, six .30 caliber machine guns and two underwater 21-inch torpedo tubes for firing the largest and longest range torpedoes.

The "Maryland" possesses all the latest provisions for protection against torpedo attacks. It is claimed by naval architects that it would require several hits by torpedoes to sink the ship by an under-water attack. The crew and vital parts will be protected by armor plate so thick that only the largest caliber shells, fired at moderate range could get through.

Displacing 32,600 tons, this fine warship, electrically driven, will have a speed of 21 knots and a cruising radius of 10,000 miles. She will burn oil, her fuel capacity being approximately 1,400,000 gallons.

The "Maryland" is 624 feet long and has a beam of 97½ feet. There will be 67 officers in the ship's complement and more than 1,400 men in her regular crew.

This most modern of warcraft recently completed her builders' trials with a perfect record. For 33 continuous hours at sea off the Virginia Capes, she was put through all sorts of tests, bringing into

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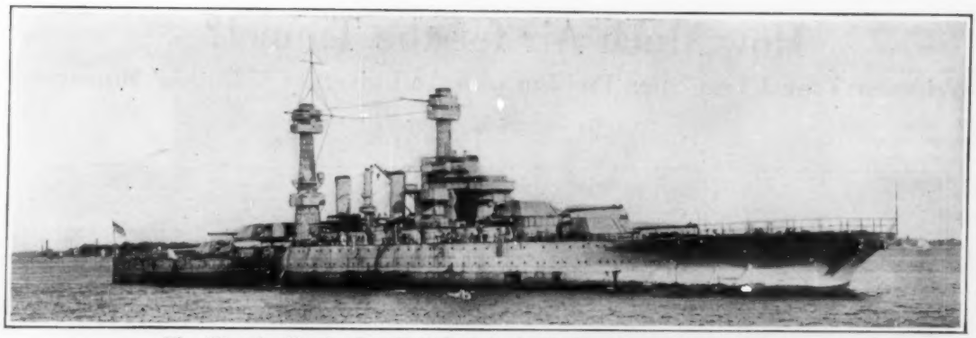
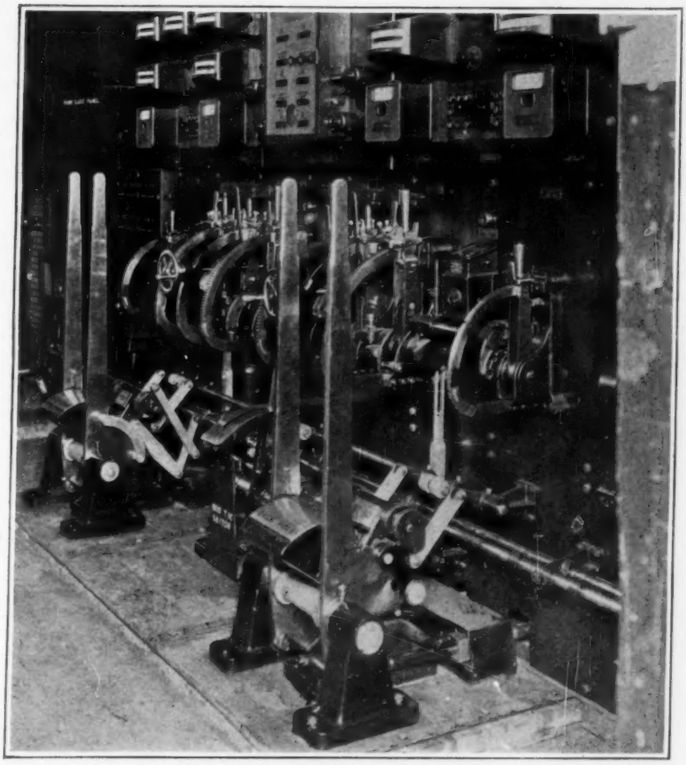


The "Maryland"—the first United States battleship to mount a 16-inch gun



Control levers and instrument board comprising the propulsion control equipment of the "Maryland"

Something New in Salvaging Equipment

By Harry A. Mount

THE almost successful raising of the wreck of the yacht "Isis," off St. Augustine, Florida, by a New York salvage concern, using ingenious but hitherto untried equipment, designed to reduce greatly the time and expense of salvage operations, suggests a possible revolution in the methods of this branch of marine engineering. The "Isis" was recently freed from the sticky bottom of the Atlantic and raised five feet, but storm and chafing damaged the pontoons. As soon as new equipment is obtained the work is to be resumed.

The equipment was designed by A. B. Salinger, an electrical engineer. It consists essentially of a number of electrical burrowing machines or "moles" for carrying a cable through mud or sand under a sunken vessel, equipment for controlling these "moles," and a new type of collapsible pontoon for raising the vessel.

Aside from the trial given this new equipment, the attempt to raise the "Isis" is of interest because she was once before raised and lost again through overconfidence of the workmen. The "Isis" was, before the war, the sumptuous private twin screw yacht of A. G. Spalding, and is said to have cost $800,000. She was built in 1902 at Newburgh, N. Y., and measures 180 feet in length. She was taken over by the Government in 1915 and assigned to the Coast and Geodedic Survey. In February, 1920, while on the way to South America, she struck a submerged dredge off St. Augustine and sank in 40 feet of water.

The Government sold her as she lay to a salvage concern and the vessel was raised by ordinary salvage methods and beached while temporary repairs were made. Confident that the work had been well done, the salvagers moved their effects aboard and two tugs started towing her to port. But the temporary repairs proved inadequate and finally, to save themselves, the two tugs cut their lines and let her sink again in about 20 feet of water. The bottom at this point is sandy and the boat sunk with one side buried deep in the sand. Because of this fact, a second raising promised to be both difficult and expensive. The wreck was

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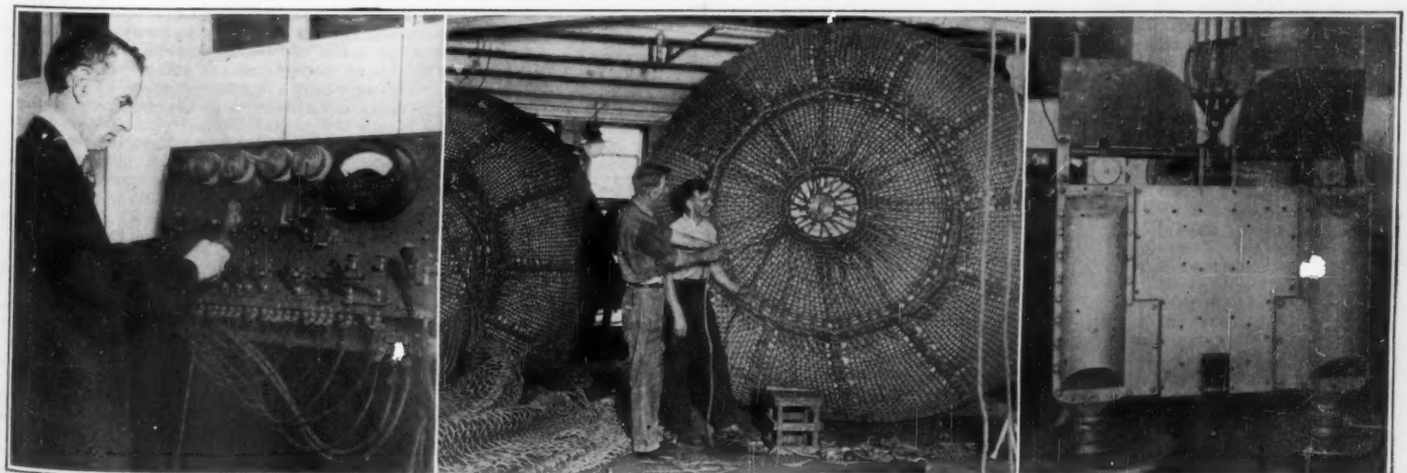


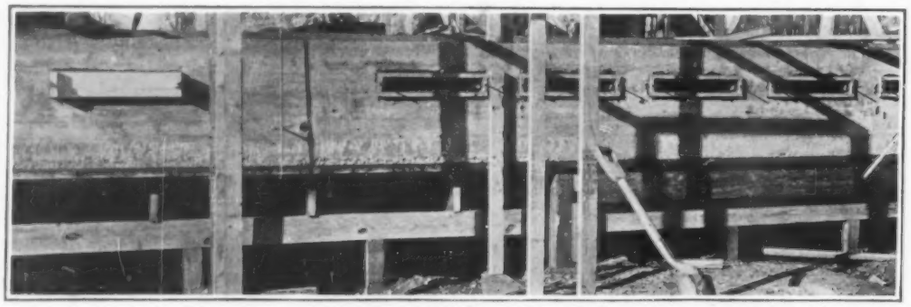
Left: The control board located on a boat at the surface, from which the burrowing machine is operated. *Center:* One of the resilient pontoons fully inflated, which is claimed to have a lifting capacity of 25 tons. *Right:* The electric burrowing machine which digs its way through mud and sand by means of a pair of electrically-driven propellers or cutters and is directed by electrically-operated rudders

Essentials of a new salvaging system which depends on the use of an electric burrowing machine and inflated bags for pontoons

How Much Air for the Tunnel?

Solving the Vehicular Tunnel Ventilation Problem with the University of Illinois' Miniature Test Duct

By George H. Dacy



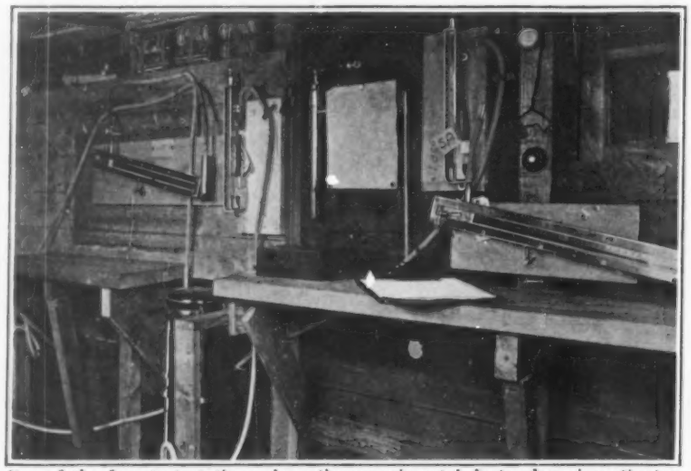
There are 224 air outlet ports in the experimental duct, which admit of the study of the wide range of ventilation conditions in the tunnel

WITH the inception of the Hudson River vehicular tunnel project, a ventilation problem arose, the like of which never before confronted the engineering profession. A previous article published in the May 8, 1920 issue of the SCIENTIFIC AMERICAN discussed in detail the plan of the two proposed subterranean tubes twenty-nine feet in diameter and 8,300 feet long between the portals, which are designed to carry two lines of traffic in each direction estimated at 1,900 vehicles an hour. Construction work has begun. It is estimated that the tunnels will cost more than $28,000,000, while it will take five years of intensive work to build them.

We know that motor cars seldom—if ever—develop complete combustion; this results in the production of a varying percentage of unsaturated hydrocarbon and carbon monoxide in addition to carbon dioxide in the exhaust gases. Carbon monoxide is poisonous and the problem arose of determining how much the exhaust gases must be diluted in order to render them harmless to the motorists who would use the tunnels

A technical explanation of the effect of carbon monoxide on human metabolism features the fact that this active poison has an affinity for the hemoglobin of the blood much greater than that of oxygen. The blood absorbs carbon monoxide more readily than it does oxygen and where the blood is saturated with the poisonous gas, its ability to transport the essential oxygen to the organs and tissues of the body is seriously reduced. Extensive experiments have been conducted by the U. S. Bureau of Mines Experiment Station at Yale University to ascertain the proper dilution by fresh air ventilation which would render the obnoxious carbon monoxide gases harmless. In these tests which were performed in a special gas-tight chamber, scientists spent periods of one hour in amounts of carbon monoxide varying from two to ten parts in 10,000. Other experiments were conducted in a large chamber of 12,000 cubic feet capacity so arranged that an automobile engine was exhausting its by-product gases directly into the gas-tight chamber. It was demonstrated conclusively that under conditions of a dilution of 4 parts or less of carbon monoxide to 10,000 parts of air that no inconvenience or disagreeable results attended. Even where the dilution was only 6 parts in 10,000 no bad effects resulted, although where the proportion was 8 parts in 10,000 the observers reported that they suffered from distinct headaches caused by the poisonous vapors. Motorists in cars going through the tunnel in 10 to 15 minutes will experience no bad effects whatever and will absorb very little gas according to the ventilation scheme which has been devised.

It was next found essential to conduct additional experiments regarding the most efficient methods of ventilating the tunnel so as to engender and maintain the proper flow of fresh air into the tunnel as well as to provide for the efficient disposal of impure air. In these interesting and novel experiments, the University of Illinois engineering college has cooperated with the Federal Bureau of Mines in the construction of a novel, miniature tunnel on the campus of the Illinois institution, which for investigational purposes could be used interchangeably as a fresh air supply duct or an exhaust air duct. This is the most important single experiment ever conducted by an engineering school relative to the determination of the coefficient of air friction, essentially a physical property. The duct, which is 400 feet in length, is made of concrete and is an accurate representation of the lower and upper ducts which ultimately will be constructed in the Hudson River vehicular tunnel, with the exception that the trial duct was built to the scale of one-half dimension and one-fourth the area of the permanent tunnel ducts.



One of the four test stations along the experimental duct, where investigator utilizes delicate recording apparatus to determine results

The experiments with the trial tunnel will cost approximately $50,000, and they represent an entirely new and unexplored field of technical engineering. Information has emanated from these unique scientific researches which is worth millions of dollars to cities which potentially will construct vehicular tunnels. This experimental work has resulted in the accurate and conclusive determination of the coefficient of friction of the flow of air in concrete ducts—facts and figures concerning which scientific and practical engineers, heretofore, have had no knowledge. The tests have also resulted in the complete verification of the formulæ used in the computation of power required for moving air through a duct from which air is taken off at intervals. They have been responsible for the determination of the power and frictional losses of ventilation air in the turns and bends of ventilation equipment and tunnel accessories. They have permitted of a careful and complete study being made of the diffusion of exhaust gases in the cross section of the tunnel and an investigation of temperature conditions in the proposed tunnel as affected by the operation of internal-combustion motors. They have facilitated the study of physiological effects of temperatures, exhaust gases and smoke in the tunnel sections under operating conditions.

In the test tunnel sector, the distributive method of ventilation has been used, the fresh air being supplied at all points throughout the tunnel, while the amount of air provided at any particular position can be controlled. Furthermore, there is no discomfort or danger from high velocity air currents which are objectionable in tunnels where the longitudinal system of ventilation is practical. According to the methods pursued in the Illinois experiments the ventilation of the tunnel will never be affected by moving traffic nor the direction of the wind. It emphasizes the rapid removal and efficient dilution of the exhaust gases.

According to the engineering experts in charge of the new Hudson River tunnel, the power required for moving the air through the ducts increases very rapidly with their length, so that it is important to make them as short as possible.

To minimize the operating costs, each tunnel will be equipped with four ventilating shafts, two located near the pier-head line and the others about midway between these and the portal. The equipment in the shaft superstructures will furnish ventilation half-way to each of the adjacent shafts. On the basis of the experimental data available at this writing, the authorities in charge of the construction of this modern Goliath of underground passageways estimate that approximately 65 large electrically-driven fans ranging from 100 to 600 horsepower apiece will be required to insure a full air supply at all times and to allow for untoward emergencies. The fresh air will be fed to the fans through open louvres in the sides of the buildings while the vitiated air will be exhausted through vertical stacks.

The circular tunnel provides space above and below the roadway for air ducts. Practical tests and experimental data indicate that the advisable location of these ducts is with the fresh air duct under and the exhaust air duct over the roadway. The fresh air coming from the blower fans at the shafts is discharged from the main duct through

(*Continued on page 55*)

The 400-foot long test duct at Champaign, Ill., built on the basis of one-half size and one-quarter area as compared with proposed Hudson River vehicular tunnel

Drying Wood in the Orient

THE method employed in drying wood in China and Japan is shown in the accompanying illustration. Bamboo stakes are driven into the ground and the planks laid between them so as to prevent the wood from warping during the drying operations. A similar method is employed when it is necessary to shape the planks or other pieces of wood.

Drying planks in China and Japan without danger of warping by means of upright bamboo stakes

Helping the Automobile Out of Sand with Chicken Wire

CHICKEN wire laid over deep and shifting sand provides almost perfect traction for the automobile, according to a San Francisco motorist who demonstrated the value of chicken wire for this purpose over a sandy stretch that otherwise could not have been negotiated.

A seven-passenger car was driven into deep sand until it would not move forward another inch. A roll of chicken wire was unwound and one end placed under the rear wheels. The car was then easily backed out of the sand. To drive forward in sand it is necessary to spread the wire in front of the car so that the rear wheels will have traction the moment they touch the sand. The wire must be at least two feet wider than the distance between the right and left wheels. The longer the roll the farther the car can be driven over sand without going through the operation of shifting the wire from back to front of the car.

Members of the party that witnessed the demonstration expressed the opinion that no tourist traveling any distance where he was likely to get stuck in soft sand or mud could afford to be without chicken wire in his equipment. The best size and method recommended is a piece of wire about three or four feet wider than the car and two or more times the wheel base. On account of the extreme flexibility of ordinary chicken wire, a piece this size could be folded once or twice and then rolled up. In this form it could be conveniently carried. When needed it would save much hard work and grief, and might well repay the owner of the car for the cost of getting it and the trouble of finding space and carrying it.

Using a roll of chicken wire to help the automobile over sandy stretches and out of sand- and mud-holes

The Crawling Yard Crane

A DISTINCTLY new application to industry of the war-time tank tractor is the crawling crane as illustrated. It is the ordinary yard or locomotive crane, used so extensively in large industrial plants, and made more useful by applying to it the mechanical locomotion used by war tanks.

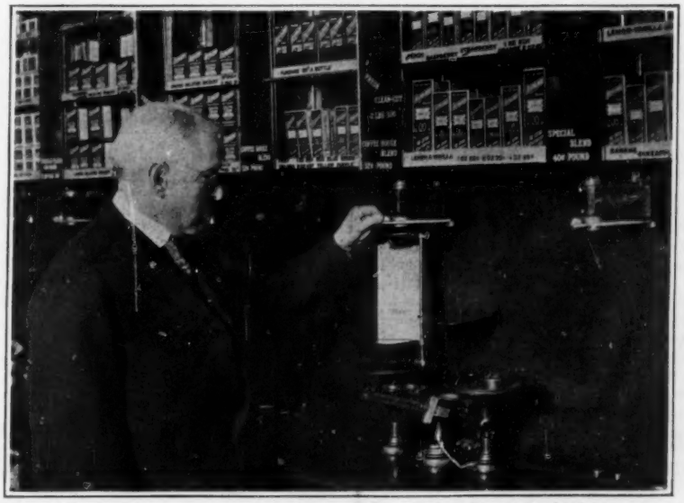
The new device is put on the market by a Chicago company. A feature is that it can turn around in any one spot or in the circle of a radius about equal to its own length. The steering is done from the cab by brakes on the differential shaft which is said to enable this unusual radius of action. Its superiority to the older cranes operated on wide and narrow gage tracks is readily understood. The crane is made in two sizes, 7-ton with 30-foot boom and 12-ton with 35-foot boom. Besides the crawling tread, it can be arranged to operate on broad-faced road-wheels or on standard or special-gage tracks.

A highly useful combination of crawler tractor and power crane that can go anywhere in the plant yard or railroad terminal

Reconstructing the Jutland Battle for the "Movies"

THE recent war has been thoroughly recorded for posterity. There is no doubt about it; for books, documents, photographs and motion pictures are available on practically every detail of the great conflict.

The latest contribution to the rather voluminous motion picture records of the war is an ingenious film depicting the naval Battle of Jutland, and recently produced in England. The stirring battle was reconstructed with infinite care and accuracy by means of miniature battleships, and animated for the motion picture film in the manner generally followed in producing trick pictures. The reproduction of a moving bird's-eye view of the Battle of Jutland for the films proved to be an immense task, we learn from *The Illustrated London News*. The work was carried out according to track charts prepared by Sir George Ashton, by a British film company, on a board measuring 8 feet square, as shown in our cover illustration. The model ships were made in three sizes—4-inch for close-ups, 2-inch for medium shots, and 1-inch long for long shots. Ships, "sea" and "sky" were painted in shades of gray. Gunfire and explosions were produced by blowing smoke through pipes. For each picture each model had to be moved only 1/16 of an inch. There are sixteen pictures to every foot of motion picture film, hence the passage of the Grand Fleet across the North Sea required 90 feet of film, and 80,000 separate movements by hand of the models. That of the German fleet required 60,000 movements.



Electrically-operated scale that shuts off the flow of material when proper weight is attained

Eliminating the Overweight Evil to Save the Profits

OVERWEIGHT in the selling of merchandise of various classes has been the cause of many stores' profits being reduced; in some cases, the profit is actually wiped out completely. Thus while merchants have been backward about buying new and sometimes expensive equipment, they have been eager enough to purchase when a demonstration proved to them that they were paying for the equipment under the old methods, but not getting it.

A week's test of a pair of automatic scales proved to a hardware merchant that he was losing on an average of $1.44 in profits per day as he used the ordinary scales. Some of his lines, rope for instance, showed a loss, being sold so closely to the cost price. In order to demonstrate, the agent for the automatic scales placed the improved scales beside the old pair, and as a package was weighed on the old a comparative weight was obtained from the new scale. Under those conditions the salesmen were as careful as possible; yet the loss in overweight was proved.

One hardware merchant figured that he was getting but 95 per cent of the price of the nails he was selling, due to loss as they were weighed into bags as purchased. He soon devised a safe method. Each hundredweight of nails of each size was given to a salesman with instructions to fill a certain number of pasteboard cartons, the cartons being of various capacities, but the total amounting to 100 pounds. There could be no overweight. The plan not only paid for the cost of the cartons but the weighing device as well, and increased the profits.

Another late weighing system that saves both time and labor is that used by the Colorado Springs, Colo., food merchant shown in the accompanying illustration. He has saved floor space by keeping his stock bins for teas, coffees and spices on the second floor from which the spices and so forth run down into glass-fronted cases above the wall ledge. Under each spout outlet for these cases is a button. As a customer orders spice from any certain case the scales are pushed under that case, the proper weight is indicated on the scales and the paper bag is placed on the upper or lower flange according to its size. The scale is then pushed back into the crescent opening allowed for it where it touches an electric connection. The lever is pulled to release the stream of spices. The scale pan on the side carrying the filling bag drops and as it reaches the center or balancing point the electric current is automatically shut off and the stream stopped at the proper quantity.

The Oil That Makes the Wheels Go 'Round

Animal and Vegetable Lubricants vs. Those of Mineral Origin Today and in the Future

By Harry A. Mount

ATTENTION has often been called to the fact that our decreasing production of petroleum menaces a vital fuel supply and it has further been pointed out that we are dependent upon this source also for lubricants without which modern industry would be quite as helpless as though without fuel.

Much concern has been expressed over the fuel situation, principally because those who own motor cars (and they comprise a large part of the population) have already felt the pinch of scarcity. But, as a matter of fact, the fuel problem is not without its brighter side, while that of a future supply of lubricating oils, in many of its aspects, is much more serious.

It has been demonstrated that we need not wait while buried vegetable matter goes through countless ages of transformation before there is available the fuel we derive from petroleum. Nearly any growing plant, when subjected to a simple process of fermentation and distillation, yields a fuel, alcohol, which when properly prepared is as good as gasoline, or even better, as a fuel. But is not the same thing true of lubricants? What of the great variety of oils and greases which are now obtained directly from plant growths and are used as lubricants, such as castor oil, rape seed oil, etc? And then, there are the animal oils and greases, such as lard oil.

Aside from the fact that all oils look and feel very much alike, there is hardly any similarity between vegetable and animal oils on the one hand, and mineral oils on the other. They are utterly dissimilar in chemical structure and physical properties. Mineral oils are hydro-carbons, while animal and vegetable oils are glycerides, composed of fatty acids and glycerine. In most cases where vegetable or animal oils are used for lubrication they are simply added to a mineral oil base to give it certain properties desirable for some specific use. The total volume of vegetable and animal oils used as lubricants is very small as compared with mineral oils and the percentage is steadily decreasing. We are absolutely dependent upon mineral oils to keep the wheels of industry turning smoothly.

The difficulty with vegetable oils (animal oils possess the same properties but are used very little for lubrication and need not be considered here) is that they all have in varying degrees properties which, while very useful in other applications, render them useless for most lubricating purposes. The most troublesome property, no doubt, is the tendency to dry out or oxidize. Certain elements of all vegetable oils unite with oxygen from the air, releasing fatty acids which are injurious to steel and leaving a residue or "gum" that must be cleaned away. The oil which lubricates your typewriter, for instance, should be a pure mineral oil if "gumming" is to be avoided.

Other troublesome qualities are those of saponification and emulsification, terms very often confused. Saponification is a simple chemical reaction whereby the oils are split up and recombine with metals, generally those belonging to the alkali group. These combinations of the major portion of the oil molecule with the metal are called soaps. The soaps of commerce are generally produced by treatment of a fat or fatty oil with caustic soda or potash, but saponification may also take place in the presence of calcium, aluminum and lead.

Then, all petroleum oils may be induced to emulsify if mixed with vegetable oil, but pure mineral oils do not possess this quality. Emulsification is a purely physical action, being the mixing of oil with water to form an emulsion. The milky liquid used in machine shops to cool the tools of high speed lathes and similar machines is such an emulsion. Some vegetable oils will emulsify by simply mixing with water, while others have to be violently agitated or in some way atomized. If a pure mineral oil and distilled water be placed in a bottle, however, and the mixture agitated and then allowed to settle for a few seconds, both liquids separate with a sharp surface demarkation and are clear. They cannot be made to mix.

The remarkable thing about emulsification is that while water will suspend a considerable quantity of soluble oil without an appreciable change of viscosity, if more and more oil is added, a point is suddenly reached where the solution thickens to the consistency of a solid. If this process is reversed, that is, if the water is added to the oil, this degree of solidity is reached very quickly. If a vegetable oil is used to lubricate a piece of machinery where water is liable to get into the oil a solid emulsion is formed. Advantage of this is sometimes taken in slow speed machinery. Thus it has long been the practise to add a small quantity of rape seed oil to the mineral base used in lubricating marine engines. The water from condensing steam forms a solid emulsion and this causes the oil to stick better to the guides, piston rods, blocks, etc., of the engines. But wherever high speed turbines have replaced the lumbering reciprocating engine the practise has had to be discarded in favor of a pure mineral oil.

These same qualities which make vegetable oils undesirable for lubrication render them invaluable in many industries. The largest use, of course, is in soaps and paints. Many varieties of oils and greases, from olive oil to fat offallings, are used in making soap.

The requirements for paint are more exacting. A good paint oil must be quick drying, and for this purpose linseed oil is used almost exclusively because it is the fastest drying of all oils. Attempts to use mineral oil in place of linseed oil in paints have given no encouragement to the experimenters. A paint consists essentially of a pigment or coloring matter and a vehicle for applying, and a thinner, as turpentine or a substitute made from petroleum. The solvent, when it dries, must leave behind some solid matter for holding the pigment and to form a protective coating. A mineral oil vehicle simply soaks into wood when applied and the first rain washes away the pigment.

LAST year and the year before, when we were all so concerned over the apparently imminent exhaustion of our petroleum deposits, the chief concern was felt with regard to the fuel of the future for internal combustion engines. Comparatively little attention was paid to the fact that not alone the automobile, but all engines and machinery of every description, are largely dependent upon petroleum derivatives for lubrication. Now that the price of gasoline is declining so steadily and even so rapidly, we are apt to think that all the problems connected with petroleum production are permanently solved. That this is not the case, that it is necessary for us to pay serious regard for the future supplies of lubricant, is Mr. Mount's text in the story on this page.—THE EDITOR.

Certain vegetable oils are regarded as essential to other industries and they are used in very large quantities. For instance, in the silk industry, olive oil soap is used to saturate the raw fiber before putting it through the various mill processes. This renders the fibers more pliable and lubricates them so that they slip easily, preventing breakage and generally facilitating all of the processes. Other cheaper oils are used for the same purpose in the wool industry.

Castor oil is an essential material in the manufacture of artificial leather and in the curing of some grades of real leather. Certain vegetable oils have become important articles of food, such as olive oil and cotton seed oil. Others, as cocoanut oil, enter in large quantities into the manufacture of other foods. Indeed, the minor uses of vegetable oils are myriad and they enter into thousands of articles of every-day use.

Castor oil represents the only apparent contradiction to what has been said. It is regarded by some engineers as essential to the lubrication of certain types of high-speed internal combustion engines, notably the rotary type of aviation motor. Some automobile racing drivers also favor the use of castor oil. There is a wide divergence of opinion here, however, and on some of the aviation fields of this country during the war mineral oils were used exclusively with satisfaction in all types of motors, even though castor oil was available.

Castor oil was first used in this way in the rotary motor for two important reasons. This motor draws its gas through the crank case and because of the affinity of mineral oils for gasoline, trouble was experienced from the "soaking up" of the gas by the oil and thinning the lubricant. It is almost impossible to mix castor oil and gasoline and for this reason no trouble is experienced from this source. The second reason is that, while castor oil is thinner at normal temperatures than the heavy oils usually required for air-cooled motors, at very high temperatures it is thicker and therefore a better lubricant. The oil in aviation motors is changed after a few hours of use so that there is not time for the undesirable features of the vegetable oil to show. Attempts to manufacture a motor oil for automobiles from castor oil, or with castor oil as a base, have generally proved unsuccessful because the oil is used for a longer time, allowing the natural reactions to set in. In addition, mineral oils are better suited to the comparative low speeds and low temperatures of automobile motors. As one engineer puts it:

"If an automobile could be kept going at sixty miles an hour and if the oil were changed at the end of every day or two, castor oil would be all right. But under ordinary driving conditions I do not believe we will ever be able to get away from the natural undesirable features."

Another reason that many motorists have been led to believe that castor oil would some day prove a panacea for their lubricating troubles, is the general air of mystery that has surrounded the subject. There are in this country only a few firms extracting castor oil and the rivalry between them is intense. The secrets of their plants are closely guarded.

But during the war when there was need of large quantities of castor oil the Government erected a plant at Gainesville, Fla., and after many disappointments and failures was able to refine a castor oil of commercial quality. The conclusions reached in this experiment have been published by the United States Department of Agriculture. The process roughly was first to clean the beans, heat them, press out the oil in a continuous process and then to treat the meal with benzol to remove the final traces of oil. Great difficulty was encountered in adapting machinery to the purpose and in developing a working technique.

The results were disappointing from the standpoint of quantity but this was largely because a crop of castor beans, the standpoint of quantity, but this was a failure. The castor bean industry is an important one in India and most of the beans used here are imported from there. The seed for the war crop planting came from India but because it was not acclimated the yield was only a fraction of what was expected. We have lapsed into our pre-war state in the matter of growing castor beans and aside from a few plants which are not uncommon as lawn ornaments, none is grown in this country.

It will thus be seen that castor oil is no exception to the general rule that vegetable oils and mineral oils each occupy a definite field of usefulness and that while they overlap to some extent there is no hope that either can take the place of the other.

There is no immediate famine in lubricating oils. Because of the large production of gasoline there is, in fact, an overproduction. This is because the same barrel of crude oil which yields the gasoline, also yields in the refining process a percentage of heavy oil. Indeed, it is now the practise to extract more gasoline from the crude by applying to the lubricating oil a "cracking" process, leaving as a final residue only a small quantity of coke.

It is not beyond conception, however, that if gasoline is displaced as a motor fuel, as indeed it must be, there will be a decided change in the economic status of lubricants, if not an actual famine.

An economical process for recovering oil from the vast shale deposits would afford relief for many years, even after the exhaustion of petroleum, but beyond that there is no substitute in sight.

Neon Lamps in Agriculture

DURING the year 1916-1917 the Horticultural Institute of Berlin-Dahlen made a number of experiments with respect to the effect of illuminating fields of tomatoes and of gherkins by neon lamps. According to *La Nature* (Paris), the surprising yields were obtained of more than 41 per cent excess over the normal for gherkins and 40 per cent for tomatoes.

The Summer Sneezer

New Light on Hay Fever, Rose Colds, and the Like

By Frank Parker Stockbridge

A HARVARD freshman committed suicide the other day at his home in Worcester rather than go back to college and be subjected to the ridicule of his fellow-students because he could not eat anything with eggs in it. From infancy, his father said, the young man's aversion to eggs had amounted to a disease; the slightest trace of egg in anything he ate made him so ill he had to leave the table. And the pity of the whole tragic incident is not only that the boy could have been cured of his idiosyncrasy but that he was only one victim of thousands who suffer from the ridicule, born of ignorance, that attributes aversions such as his to whim or obstinacy, or—in the case of girls—to "nerves." Few go to the length of suicide, like Barton Fay, but many become morbid, hypersensitive and anti-social because in childhood and adolescence they have been laughed at for saying that certain foods or the mere presence of certain substances or objects made them ill. Many others go through life as semi-invalids because they and their physicians fail to attribute their frequent attacks of illness, often with symptoms like poisoning, to some common article of food which has caused them.

Such susceptibility to poisoning by eggs as the young Harvard student exhibited is now regarded by physicians as in the same class with poisoning by plant-pollens, the most familiar manifestations of which are "hay fever" and its earlier prototype "rose colds," and with the aversions to certain animals felt by many persons who claim that contact with or the mere presence of horses, cats, dogs, chickens, sheep or cattle makes them ill. That such susceptibilities and aversions do exist has long been known. Shakespeare makes Shylock speak of persons who go mad in the presence of "the harmless necessary cat," and there are references in medical literature to "rose colds" as far back as 1565; but it is only within the last few years that the common cause of all of these phenomena has been known and a ready means of diagnosis and treatment made available to the world at large.

Reduced to the simplest terms, it is now known that certain individuals are hypersensitive to certain proteins, whether these enter the system through the stomach or through the air-passages; the symptoms are usually bronchial and often asthmatic, usually accompanied by a rise in body temperature and often by blotches or other skin eruptions. The diagnosis is simple; the skin is scratched slightly, not enough to draw blood, and an extremely dilute preparation of the suspected protein rubbed in. Sometimes, as in hay fever cases, the pollen proteins of a dozen different plants and weeds may have to be tried before a positive reaction is manifested by the appearance of a well-defined circular blotch centering at the scratch-point. And the treatment consists in administering minute but gradually increasing doses of the offending protein by the mouth or subcutaneously, until immunity is established, which in many cases comes about very promptly—a modern application of the ancient remedy, "a hair of the dog that bit you."

Literally, proteins of cat hair, dog hair, cattle hair, chicken feathers and similar animal integuments, as well as of the pollens of all sorts of trees, grains and weeds, from ash to willow, including goldenrod and ragweed, and of foodstuffs of every ordinary and some extraordinary kinds, are now available and in daily use for the detection and treatment of just the sort of susceptibility that drove poor young Fay to suicide.

Sometimes treatment even more simple than this is all that is necessary for a cure. Lumbermen in north woods used to make it a point, if they were at all susceptible to poison ivy, to hunt up a vine and eat a few of the leaves on first entering the woods for the season. A few hours of the violent illness thus induced rendered its heroic victim immune for the rest of the season!

Not long ago a man and his wife called on a New York physician who was familiar with this rough-and-ready prophylaxis of the lumber camps. Both complained of annual attacks of "hay fever" though each was affected at a different season, indicating that the trouble with each arose from a different cause. To the experienced eye of the physician the peeling of the skin on the man's face—they had just come back to town from a summer in the country—looked like the effects of poisoning by *rhus toxicodendron*, the "poison sumac" of northern woods.

"Go back to the country and eat a few poison sumac leaves," the doctor advised. "You'll be pretty sick for a day or so, but I think your condition will then clear up quickly. Do that every autumn, as soon as the leaves begin to turn."

The man took the doctor's advice and for three seasons since has been immune from the "hay fever" that formerly made the last few weeks of his stay in the country a season of misery.

The wife was sent to a diagnostic laboratory where tests were made with several vegetable proteins and the pollens of a number of June plants, weeds and grasses. She reacted to none of them but the strawberry protein. It had never occurred to her that eating strawberries was poisoning her; her symptoms were all those of one who has "taken cold," with intense coryza, sneezing and choked breathing. The next spring she abstained from strawberries and had no recurrence of the "hay fever." Then she underwent treatment with strawberry proteins with the purpose of obtaining permanent immunity, and after a year of such treatment was able to eat strawberries without experiencing any ill effects.

Instances might be multiplied indefinitely like these. The widow of a famous medical expert had all her life been unable to remain in the same room with a bird of any kind. (Her husband had died before medical research had discovered the true cause of such "phobias.") It took several months of treatment

(*Continued on page 55*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

A Question of Disarmament

To the Editor of the SCIENTIFIC AMERICAN:

Apropos the [illegible]e sizes of the world's navies, built, building and s[illegible]ned, I have been in full accord with your posit[illegible]at the Navy of the United States is quite powerful enough in capital ships, though it needs many more fast light cruisers and more attention to the Naval aero service.

In view, however, of a contribution to *The Naval and Military Record* by Hector C. Bywater from which I quote a striking passage below, it may be that the late administration was not mistaken in pressing for a still larger navy. The passage reads:

"It is only in 1923 that the ratio will begin to show a marked change, but by the end of the following year—assuming that we do no building in the meantime—it will have completely altered, the American figures then being: First-line ships, 16; second-line ships, 11; against the British totals of 13 and 15. And the slight numerical balance in our favor will be negatived by the immense individual superiority of the later American vessels. At the beginning of 1925 the Japanese position will probably be as follows: First-line ships, 16; second-line ships, 8."

I do not know that Mr. Bywater's figures are correct, but, if so, it would appear that, in order to insure the peaceful progress of the United States, it will be necessary to build more capital ships in addition to light cruisers and other special craft so as to make a well balanced navy.

Naval and military disarmament would indeed be a boon to a war-tired world but, until all the great powers will approach such an agreement in an honest and open way, leaving all disputes to be settled by an impartial court of arbitration, the only safe policy is Roosevelt's "Just man armed."

Antigua, B. W. I. INTERESTED READER.

"His Hair Turned White Overnight"

To the Editor of the SCIENTIFIC AMERICAN:

In reply to the article in your correspondence column of March 26 last, captioned as above, I think the following quotation from "Forty Years in Phrenology," by the late Nelson Sizer, will explain a great many of such cases:

"In the fall of 1854, Mr. John Wallace, of Covington, Miss., aged twenty-seven, called at our office for an examination. He had large cautiousness, and we observed a tuft of hair perfectly white of the size of a half-dollar on each side of his head, directly in the center of the organs of cautiousness. We stated to him our opinion that he had been pursuing a business involving a painful activity of cautiousness, like powder-making, or that he had been cast away at sea, in constant fear of a violent death. At the close of the examination he stated that he was upset from a sail-boat in Lake Pontchartrain, when sixteen years of age, and held on to the bottom of the boat all night, in imminent peril of life, while his companions became exhausted and were lost. In the morning he was picked up by a vessel and carried to New Orleans, when it was discovered that his hair had turned gray on the places above described, which soon became white, and has remained so ever since. His hair being black, renders the contrast of the white spots very striking."

Likewise, O. S. Fowler, another of the prominent phrenologists of the past century, known throughout the Eastern States by his popular lectures on the subject, stated in his "Human Science," page 201, that he knew of "cases by hundreds in which fear of death by shipwreck or foul means or accident, continued for a few hours, have turned the hair gray over caution, while the hair in all other parts of the head retained its natural color."

It should be stated that the phrenological organ of Cautiousness is located in the angular gyrus, under the parietal eminence, which is the horizontal ridge quite noticeable in many heads about three inches above the tops of the ears and slightly backward from this point, on each side of the head, the size of the organ being indicated by the width of the head at this point.

The writer has studied and investigated phrenology for the past twenty-five years and knows of a case of a woman residing here whose hair fell out over the organ of Conjugality (conjugal love) on each side of her head while her husband was in a hospital undergoing a capital operation, and then the hair grew again, but came out white, and has been white there ever since. Conjugality is located about two inches directly back horizontally from the meatus of the ear, and is the specific faculty of love between husband and wife and sweethearts, and of fidelity, constancy, etc. Evidently the intense activity of this part of the brain resulted in the congestion, or inflammation, extending to the surface of the head, thus causing the hair to fall out. Perhaps this is the true explanation of what happens in all these reported cases of the hair turning white overnight, and the white scalp showing through the thinned covering of hair gives the appearance from a distance of the hair having turned gray or white, even before the hair has grown out again and become actually white. All chance of coincidence is nullified by the hair being white on both sides of the head at the same point, which proves that the cause was inflammation of the corresponding parts of each hemisphere of the brain. Thousands of cases in which a particular part of the brain surface has been so over-active and inflamed on each side of the head that the heat is easily detectable with the fingertips, have been noted and recorded by phrenologists, and it is also proved by repeated observations that the hair turns gray first over the most active parts of the brain. I recently saw a man with a triangular tuft of white hair just below the center of the back of his head, directly over the phrenological organ of Philoprogenitiveness, or love of children, and on inquiry found that he was a man remarkably fond of his children. As to cases in which the hair of the whole head turned suddenly white, I have never heard of such.

Livermore, Cal. ELMER G. STILL.

A Rare Feat

To the Editor of the SCIENTIFIC AMERICAN:

From an advertisement in a leading trade paper, back cover, issue of June 16, 1921:

"This formula approximates that of bronze, but microscopic examination shows that *N* - - - - - has a very different and denser molecular structure."

I've heard of microstructures—seen many of them in fact. But seeing molecular structures is an achievement which deserves the notice of your journal.

New York. M. F. B.

Clusters and Nebulae

Some Startling Facts and Figures Concerning These Interesting Astronomical Features

By J. F. Springer

GLOBULAR star clusters constitute one of the most notable classes of celestial objects. Unlike nebulæ and stars, they appear to be limited in number. Space is, apparently, not at all crowded with them. The total number so far discovered is around 86. As only about six or seven per cent of these are clusters added in the course of some 80 years, despite the great number of observations and the high powers of the instruments, it begins to appear as if the reason why globular clusters are being found only at the rate of about seven a century is because we are approaching the end of the list.

Perhaps the most remarkable of all the globular clusters is the Great Cluster in Hercules, the celebrated Messier 13. To the naked eye sharp enough to discern this object, it appears as a faint, hazy star. It is some 2 deg. south of Eta Hercules. When the cluster is brought fairly into the field of a telescope of considerable power the minute patch of haze is resolved in a host of minute points. The globular form is not especially apparent; but in the region of dense population, three dark spokes or radial lanes are seen. These roughly divide the starry region into three approximately equal sectors. But a more recent view of the great cluster, obtained photographically by Professor Ritchie by an 11-hour exposure of a plate of medium rapidity, fails to show the dark lanes. This view brings out more clearly the globular appearance. On this plate, H. Shapley informs us, are recorded more than 30,000 star images brighter than the 21st magnitude. The negative was produced by the use of the big 60-inch reflecting telescope of the Mount Wilson Observatory. It is no great wonder that some have regarded such aggregations of stars as other universes. In general, they are more or less isolated in space, the surrounding regions being very sparsely populated.

The Great Cluster in Hercules is so far away that it is useless to attempt to determine its parallax—the angle subtended at the object by a radius of the earth's orbit—by ordinary methods. However, by studies of "the frequencies of the colors and the apparent magnitudes," the conclusion has been reached that the parallax lies somewhere between 0″.00001 and 0″.00010. A further study—one involving Cepheid variables, red giant stars, stars of spectral type B, the apparent diameters of clusters—has resulted in the choice between the foregoing limits, but fairly close to the maximum; that is, 0″.00009. This means that the Great Cluster is some 36,000 light years away. This means in turn, since one light year $=5{,}875 \times 10^{9}$, the distance is 211,500,000,000,000,000 miles. The Ritchie photograph shows this cluster not as it now is, but as it was 36,000 years ago when the light now arriving started on its way. In fact, this is not a sufficient correction, as the cluster negative, for example, has been on the way 160 light years. Some of the light arriving to make this negative bad, for example, has been o nthe way 160 years longer than other light. It is something like a newspaper in the pre-telegraphic days. Some of the events narrated had just transpired, because the *locale* was near-by; other events had happened weeks or months before, the news having just reached the journal because of the distance it had to come.

This brings us to a more general fact. We never see the heavens as they really are or even were, but see an unreal image made up of infinitesimal patches having dates of an enormous range. The enormous size of this giant cluster may perhaps be better grasped if instead of saying that it is 160 light years across, we say, with Shapley, that a star at the distance of a cluster-diameter from us would have to be 100 times as bright as our sun to become visible to the naked eye. And yet this diametral length is a distance almost out of all comparison with the distance of the cluster from us. If we measure off a line 14 inches long and then place at one extremity a steel ball 1/16 inch in diameter, we will have a means of comparing the cluster with its distance from us. [Author's note: I have taken as the cluster proper, the central condensation. Shapley estimates the aggregation as having a diameter more than twice as great.]

What does the sparseness of stars in the space around a cluster mean? Is the cluster the condensation of stellar bodies which originally occupied a more gigantic region? Or, are the globular clusters young aggregations, aggregations which are in an early stage of expansion? Or, is there some other and distinct explanation? No man can give answers that are reasonably certain to be true; at best, it is merely guesswork.

But let us look within the cluster a moment. The stars seem, especially those toward the interior, to be very thickly congregated. This appears to be the actual condition of affairs. The nearest star to our solar system is usually taken to be Alpha Centauri. Its distance is 3¼ light years. If our sun be taken as the center of a sphere having this radius, there would be but one star within that sphere and this star would scarcely be within. But, if one turns to the Great Cluster in Hercules, and attends to a *circle* of the same radius, this circle being placed at the center of the cluster image, he will, it is said, in effect, find thousands of stars within it. Of course, there are stellar points here belonging to the full diameter. That is, we have, neglecting stars behind one another, thousands of stars in a cylinder, which corresponds to the circle and is 160 light years deep. There could be put some 24½ spheres in this cylinder, and they would fill two-thirds of the space. Roughly, then, the amount of space whose stellar inhabitants are sending their images to the center circle of the Ritchie photograph are those of 36¾ times the space occupied by the sphere. So, then, we may divide the thousands by 36¾ and still obtain a goodly number. In such a sphere we have two stars—our sun and Alpha Centauri. Apparently, the center of the cluster is very many times as thickly populated as our region of the universe.

Quite recent work on globular clusters is understood to tend in the direction of showing that the form is not truly spherical but slightly elongated. This, if completely confirmed, will be a big fact. The Great Cluster in Hercules is one of the most flattened of the oblate spheroids. This may not be recognizable, perhaps, from mere observation. But counts of the stars in the t .copic photographic projection of the cluster show that in the direction of one particular diameter there are about 30 per cent more stars than in the direction of the diameter perpendicular to it. There is some reason then to view this cluster as somewhat elongated in the direction defined by the first diameter. Naturally the question arises: Is this flattening of the spherical form due to rotation? This cluster is thought to contain not less than 100,000 stars. The total mass must be enormous. As a whole the cluster is moving at a rate not slower than 125 miles per second. This 125 miles per second is the velocity toward us and the general galactic plane.

Research, coupled with the use of assumptious seemingly probable, has resulted in the completion of a list of the distances of 86 celestial objects, nearly all of which objects are definitely known to be globular clusters. As the precise locations in the sky are known, it is possible, by combining all these items, to map them in space of three dimensions. If, now, first of all, we consider the apparent distribution—that is, without reference to their distances from us—these clusters will be found to be located mostly in the Southern Hemisphere of the skies, only about a dozen being in the Northern Hemisphere. But most of the dozen are relatively near us. In the Southern Hemisphere the globular clusters tend to positions near the Milky Way. Thus, quite a number are to be found in the constellations Scorpio, Sagittarius, Centaurus. But while these clusters seek nearness to the Galaxy, they are almost entirely absent from a belt 10 degrees wide bisected by the plane of the galactic circle. This state of affairs is in wonderful contrast to the apparent distribution of the more numerous class of *open clusters*. These clusters tend to congregate close to the galactic circle, and to become very much less numerous at short distances on both sides. We have in the foregoing a large fact with respect to both classes of clusters. Their distributions, as viewed from the earth without reference to distance from us, apparently have some close relation to the position of the Milky Way. It is such facts as these that make it difficult to believe that globular and open clusters are universes really isolated from our stellar system—that which is largely defined by the Galaxy.

Consider for a moment the broad situation. The concentration of open clusters lies in a narrow belt divided along the middle by the gigantic circle. The concentrations of the globular clusters lie in narrow belts just outside of the belt of open clusters. There are practically no globular clusters in the strip where the open ones lie. Part of the foregoing could be pretty well explained if we conceive the Milky Way to be exteriorly surrounded by a ring of dark matter—cold gas, for example. The absence of globular clusters would then mean simply that there was none inside the circle of the Milky Way and that those outside were hidden from view by the occulting matter. The presence of open clusters in precisely the belt where globular clusters are absent would mean that they are inside the Galaxy and comparatively near. If we understand that the Milky Way defines a region destructive of the globular condition, then the absence of globular clusters and the presence of open ones inside the Great Ring is explained. The open ones are the residues of globular clusters. But we have still on our hands the great fact that both descriptions of clusters are very sparsely distributed in high galactic latitudes. Why is this? The 86 globular clusters are evenly divided between the two sides of the galactic plane. Something similar may be said in respect of the open ones.

In a broad way, the nebulæ supplement the clusters. Where clusters are lacking, there are plenty of nebulæ; where nebulæ are lacking, there are plenty of clusters. But the numbers of the two great classes of objects are quite different. There are many nebulæ and comparatively few clusters. Still, the supplemental idea is to be held. We might understand the matter better if we could conceive that in some way a group of nebulæ corresponds to a single cluster. Thus, we might think of many nebulæ combining in some way to form a cluster; or we might conceive of a cluster producing many nebulæ. If either conception can be seriously entertained, it helps us to simplify our ideas of the universe as a whole.

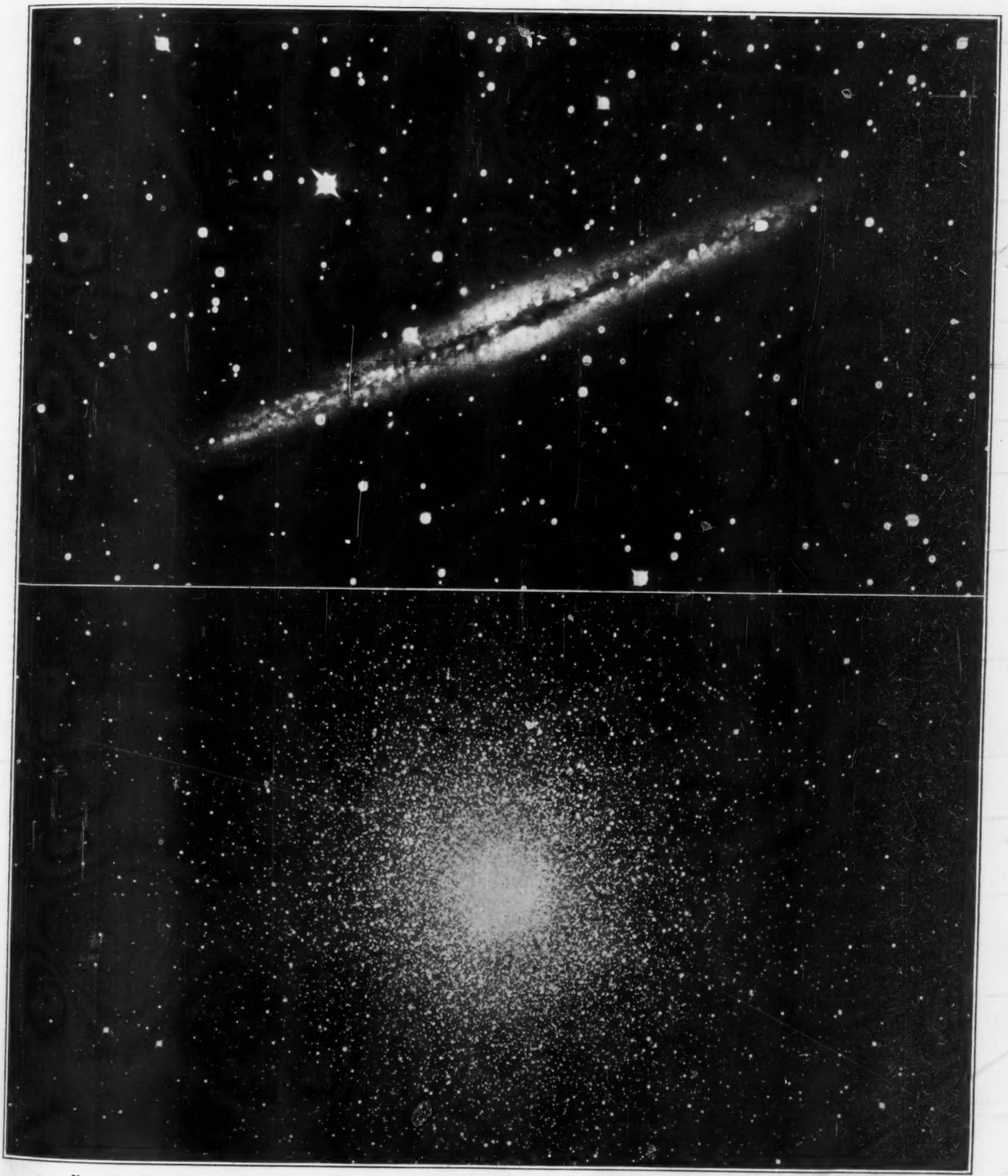
The distances of the globular clusters are enormous. The one that is supposed to be nearest—Omega Centauri—is some 20,000 light years distant. A certain cluster in the constellation Delphinus is perhaps the most distant one of these objects. It is thought to be 220,000 light years away. This is getting into the same class of distances as the length of the diameter of the Galaxy. A couple dozen of the globular clusters are judged to be at distances greater than 100,000 light years. If the group of 86 clusters be contemplated as a gigantic whole, it is seen to form an ellipsoidal system with the plane of the Milky Way dividing the ellipsoid symmetrically with 43 clusters on each side. The long diameters of the ellipsoid are apparently not less than 300,000 light years long. That is, these dimensions are substantially identical with the long diameter of the Milky Way itself. The short diameter of the globular-cluster system is reckoned at, say, 150,000 light years, but the length is by no means definite. It has been proposed that the system of globular clusters be viewed, tentatively, as coextensive with the Galaxy and as having the same equatorial planes and possibly as having the same center. In short, in the eyes of some, the globular system is part of a great organization and the plane of the Milky Way is a basic feature of this organization.

The globular clusters are all, apparently, without any absolutely known exception, distant from the galactic plane. The nearest one of the 86 is 22 Messier (in Sagittarius). This cluster is not so well defined as a globular system as others. It is, in fact, one of the most open of the whole group. But even this, relatively open, cluster is some 4,000 light years distant from the plane of the Milky Way.

The practically complete absence of globular clusters from a belt along both sides of the galactic equator is a notable fact. Are they really absent from space in this region, or are they simply hidden from our view because of the intermediate presence of dark matter? This is a question that cannot with any certainty be answered at the present moment. However, the region is a wide one, the total width of the zone of absence having been estimated as some 12,000 light years broad. In this region, some open clusters and blue stars which are thought to be as far away as some of the globular clusters, have been discerned. Just what part obscuration plays is at the moment indeterminable.

The nebulæ, particularly spiral nebulæ, avoid the region of the Milky Way. Nebulæ, apparently small and white in color, exist in large numbers near the north pole of the Galaxy. There are some, but they are distinctly less numerous, near the south pole. It has been ascertained that nearly all these white nebulæ are spirals. Of the spiral nebulæ as a class, it may be said

(*Continued on page 55*)



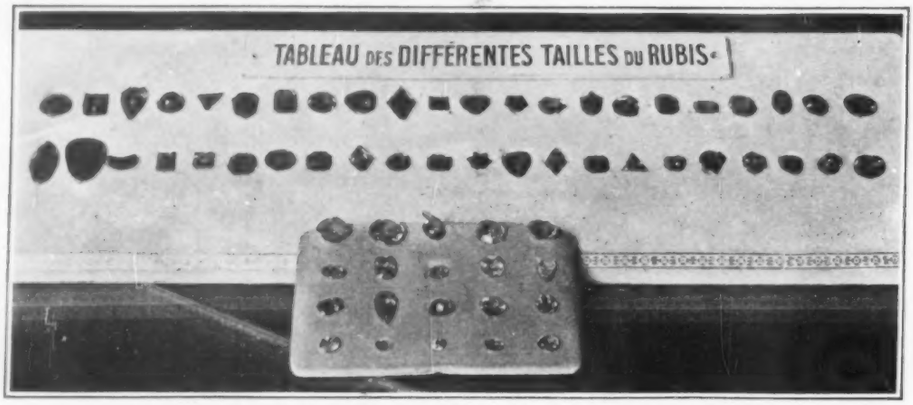
Upper View: This photograph is presumably the "spiral nebula on edge." The quotation is taken from the Mt. Wilson catalogue statement
Lower View: The great globular cluster, one of the greatest objects in the heavens

Man-Made Precious Stones

Efforts of the Past and Present To Produce Synthetic Rubies, Sapphires, and Even Diamonds

By C. M. Lewis

FOR almost a century, chemists have been trying to manufacture precious stones, finally succeeding to such a marked degree that only the experienced eye of the lapidist can distinguish between the natural gems, which come from mines, and the "scientific" stone, as it is sometimes called, which is produced in the laboratory. It is interesting to follow the series of experiments by which this process of manufacturing precious stones has been perfected.



A display of the different shapes in which rubies are cut for use in jewelry

With the exception of the diamond, which is composed of pure carbon, most precious stones are composed of aluminum, whose uncrystallized hydrate silicates or clays are quite commonplace substances. Crystallized aluminum, or corundum, on the other hand, occurs much less frequently. Sometimes it is white or colorless, and sometimes different metallic oxides give it color and brilliancy. Our precious stones, the ruby, the sapphire, the emerald and the topaz, are natural specimens of corundum, red, blue, green and yellow.

The first attempt of the chemist to reproduce these precious stones was made by liquefying aluminum, adding a colorant and then causing its crystallization by a cooling process. As early as 1837 Gaudin, and later, in 1850, Sénarmont, worked out the composition of corundum. At about the same time, Ebelmen, director of the *Manufacture Nationale*, at Sévres, made microscopic crystals of ruby by heating a crucible containing aluminum, boric acid and chromium in a porcelain oven. A little later, Henri Sainte-Claire Deville and Caron, by utilizing the reaction of anhydrous boric acid vapors on the fluoride of aluminum, succeeded in making rubies in the form of thin crystal-like scales. Again, in 1865, Debray and Hautefeuille undertook the problem. But it was M. Fremy, with his two assistants, Feil and Verneuil, who at last succeeded in working out a satisfactory solution. This was accomplished by a most remarkable series of experiments conducted from 1877 to 1890.

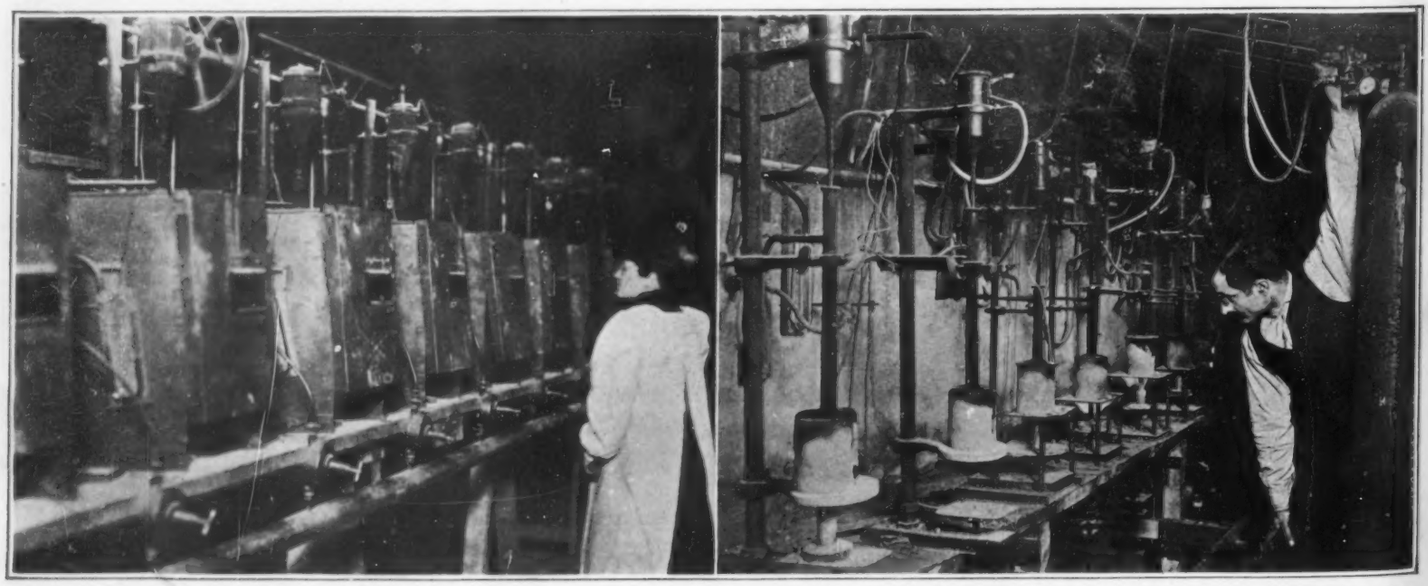
The first method used by Fremy and Feil was to form an aluminate of lead. This aluminate was then decomposed to free the aluminum and produce its crystallization. Rubies were produced by adding bichromate of potassium to color the crystals red; or, a little cobalt oxide was used as a colorant to make sapphires. But the crystals were still too scale-like and fragile to be used by jewelers. In a second series of experiments, Fremy and his second collaborator, M. Verneuil, brought about the crystallization of aluminum at high temperature by utilizing the action of the fluoride of barium in the presence of potassium. Due to an accident a little air was allowed to circulate in the crucible, and as a result beautiful rhomboid crystals were formed—rubies as clear and brilliant as those found in mines and solid enough to be cut. But the crystals were still too small to be used as jewels.

It was about this time, in 1882, that Diener Wyse displayed in Switzerland rubies of such brilliancy as to create a sensation among lapidists. It is believed that he made them by combining bits of natural ruby by fusion. Although they were fragile, he sold them for as much as 100 to 150 francs a carat. According to Friedal, these crystals had all the properties of the natural ruby, except for the appearance of gaseous bubbles and a little lighter density. When they were examined in the spectroscope they showed the same absorption bands as appear in the natural ruby. A little later, the chemist Maich succeeded in making ruby in large blocks, but his product did not possess the clear transparency of the natural ruby.

About 1895 another French scientist, Michaud, put on the market a "scientific" ruby and commercialized the process of its manufacture. First, a small ruby was placed in a platinum crucible and stood up in the center of a revolving tray, where the flame from an oxidizing blow-pipe brought it to a temperature of 1,800 degrees. Then small bits of ruby were added. These particles liquefied, united and recrystallized in a mass which could be cut. This work required, of course, great skill, since there was great danger of the crystals being splintered in the cooling. Rubies made by this process cost as much as 12 francs a carat. But they were so like the "real thing" that when they were sent to German, American and Indian markets, they were sold back to Parisian jewelers for natural stones!

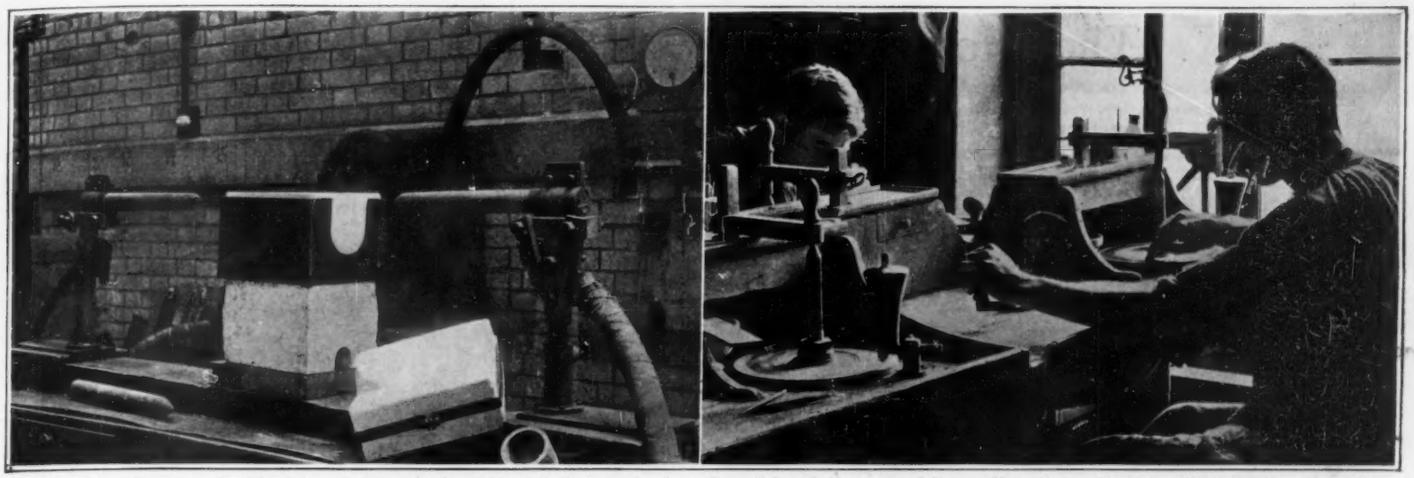
M. Verneuil went on with his experiments in collaboration with his pupil, Paul Maquier.

In Verneuil's process, first of all alum is calcinized and usually salt of chromium is added, which, according to its degree of oxidation, will color the resulting crystalline sediment red or blue. This mixture is sifted through a fine sieve. Pulverization is effected automatically by means of a very simple device. Flat brushes are fastened to the handles of horizontal levers, a little motor turns them inside the sieve, and the sediment is thus forced through the holes. The powder enters a little reservoir fitted to the upper part of a gas jet. A mallet operated by an electro-magnet taps at regular intervals on the cover of the reservoir, causing the aluminum, now pulverized, to pass through a grating and to fall in the tube to a pipe which opens near the lower hole of the reservoir and leads from the oxygen compressed in steel cylinders. The workman opens the spouts of these reservoirs slightly to obtain a temperature of 1,800 to 2,000 degrees. In each of the gas jets the current of gas draws the powdered aluminum across the flame, and it is transformed into tiny incandescent drops, some of which fall into a platinum cup surrounded with a fire-proof clay covering to prevent the loss of heat. This insulating covering is in two parts which can be brought together, with an opening left in the center where the experimenter can watch the work. As the aluminum cools, it crystallizes and the block of ruby becomes larger. Each of the gas jets makes, on an average, ten carats an hour,



Left: A battery of furnaces for the production of synthetic sapphires as employed in a French artificial gem factory. *Right:* A battery of furnaces employed in the production of artificial rubies

Some of the apparatus employed in the making of synthetic sapphires and rubies



Left: Electric arc furnace employed by Moissan in the production of his synthetic diamonds, shown dismantled, with the cover and the crucible resting on the table. *Right:* Polishing the synthetic gem by holding it against a revolving bronze disk covered with wet rotten stone

Electric furnace employed in the production of artificial diamonds and the polishing of the synthetic stones

and the blocks of ruby can be made as large as 80 carats. When the blocks have reached the desired size, the flame is extinguished quickly. This sudden cooling gives the stone a temper and facilitates the breaking of the mass.

When the fusion has been accomplished without accident, pieces of the ruby are easily broken off with pliers, and, because of the temper, the break is clean and sharp. Otherwise the stone splinters and disfiguring cracks occur. The particles thus broken off must then be cut into various shapes and polished. These two operations are very similar. The ruby is set in a kind of cement on the end of a stick. For cutting, the workman presses the stone against a copper grind-stone covered with coarse powder. After it has been cut to the desired shape and size to give it brilliancy and transparency it is polished by rubbing it against a bronze grind-stone powdered with wet rotten stone. One of our illustrations shows the most popular forms of cut rubies.

Such was the state of the ruby industry when, in 1908, M. Louis Paris, a student at the Pasteur Institute, announced that he had manufactured a sapphire. Up until this time chemists had not succeeded in adding to aluminum any substance other than chromium, since aluminum threw off foreign substances in the process of crystallization. M. Paris, however, added lime and magnesia to liquefied aluminum to prevent its crystallization, and then added cobalt as a colorant. The aluminum, the colorant and the foreign substance, finely pulverized, were put in an oven and brought to a temperature of 1,700 degrees. After baking, the powder was placed in reservoirs, as may be seen in our illustration, above heaters which operate on the same principle as those used in the manufacture of rubies; they differ from latter only in certain details of construction. In particular, a sheet-iron box (instead of the fireproof clay insulator) insulates each step of the process, and has in it a red pane of glass through which the work may be watched.

The artificial sapphire, however, is not nearly so good an imitation of the natural stone as is the manufactured ruby. It is only a chemical composition which has a density and durability very little like that of the natural sapphire. The scientific ruby, on the other hand, is almost identical to the mined ruby. The layers of crystallization are as clear in the man-made ruby as in the natural stone; air or gas bubbles are visible when examined under the microscope in both the real and the imitation stone. In fact, the eminent geologist Lacroix thinks it is impossible to distinguish between them with certainty.

So much for the ruby and the sapphire. But it is the diamond which has baffled the scientist in his experiments. By innumerable processes has he tried to manufacture that most valuable and elusive of stones.

The chemist Moissan has succeded in reproducing it, however, by uniting high temperature and strong pres-

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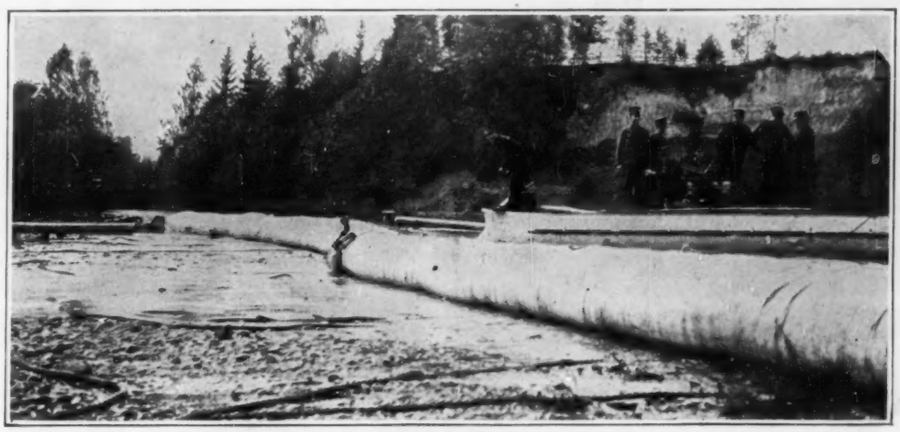
Laying out the water hose across a shallow river, preparatory to filling the hose with water so that it may dam up the river



The water hose dam filled and serving to hold back the river water. Note the relative levels of the water on either side of the hose dam

A Water-Filled Hose That Controls Shallow Rivers

THE practicability of damming shallow rivers by means of a large hose filled with water has been demonstrated by Norwegian engineers. It has also been shown that this invention is of great practical value in molding concrete under water, making it possible in some cases to eliminate cofferdams in building bridge foundations, etc. This method can be used for raising the water level in irrigation canals, for protecting levees and river banks, for lumber drives, and for military purposes.

To give an illustration of how this system works: It was decided to bank up and shut off a branch of the Randsfjord River, in Norway. The river bed at the point selected consists of small stones on underlying ground of pebbles, gravel and clay. The bed was therefore leaky and could be readily washed away. The hose used was of cotton canvas; it was 150 feet long and 40 inches in diameter. It was anchored by cables to stakes set in the bed of the stream, and the ends were anchored to the shores. One end of the hose was closed. A standard one-man diaphragm pump, mounted on a military pontoon, was used to fill the hose, about 20 minutes being required to fill the hose completely. After the big hose had been used 48 hours as a dam it showed that it served nearly as well as at the beginning.

This method has proved of value in raising the water level in sluggish streams where logs are left on the banks and shallow places. By the gathering of large masses of water above and their sudden release, artificial tidal waves are caused, releasing the logs.

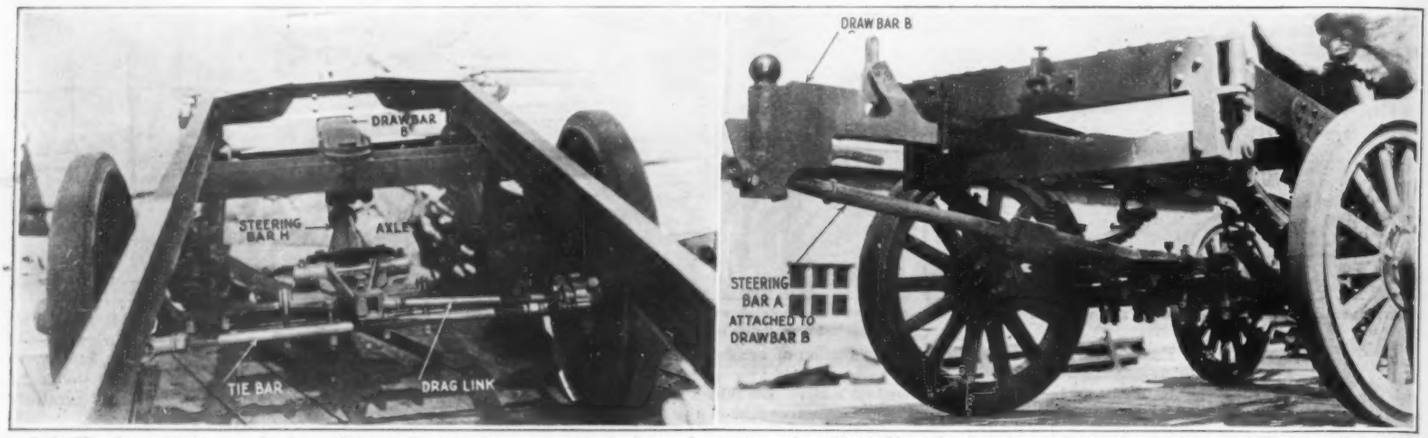
Foundation works and fords are rendered possible for short periods by repeated banking-up of the water.

It has been shown that it is possible to apply the same principle to the casting of concrete, and at the same time to avoid the washing out of the materials and the use of cofferdams. A strong and flexible canvas covering is given the desired form, is lowered empty to position and anchored. The liquid mortar is then poured in under pressure.

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles



Left: **Showing steering mechanism of four-wheel trailer and method of attachment to axle.** ***Right:*** **How the drawbar and steering bar are attached together for the forward movement of trailer, so it will track with truck towing it**

New Four-Wheel Trailer

ONE of the greatest objections against the use of four-wheel trailers has been the fact that they did not, under all conditions, properly track with the trucks. A prominent trailer manufacturer claims to have solved this problem by a steering arrangement which, by the long leverage of the steering arm, guarantees complete control of the steering mechanism, thereby eliminating any possibility of any deviation of the trailer from the path of the truck. A further serious objection against old type four-wheel trailers was that they are hard to operate in places difficult of access and hard to steer when backing up.

By a radical departure from methods employed in the past this maker is providing for the attachment of the steering arrangement to the drawbar when the trailer moves forward and with the axle, in a locked central position, when the trailer is to be backed up. This new method eliminates the possibility of knifing the drawbar when the trailer gets into a cramped position when backing up and the damage usually caused in such an emergency.

Under the new method, when backing up, the front wheels of the trailer are locked in a permanent position parallel to the frame or at right angles to the axle, while the drawbar is permitted to swing to either side without possibility of damage as the drawbar is now disconnected from the steering arrangement and receives nothing but the rearward push of the truck for the purpose of moving the trailer backward. During the backward movement, the guiding of the trailer is effected by an auxiliary steering bar to be applied to the rear end of the trailer. In extreme cases, for instance, when the problem exists of moving the trailer around a post, both sets of wheels can be arranged at any angle, which will permit the movement of the trailer around any obstacle.

By providing the possibility of attaching or detaching the steering arrangement at will, or as necessity demands to or from either the drawbar or the axle the maker has provided the flexibility of operation which is so desirable. The method of detaching from and attaching to the drawbar or axle, as the case may be, is extremely simple and fool proof, the principle of universal ball and socket joints being maintained even in this detail of construction. Construction of the trailer itself does not vary in the construction of four-wheel trailers in the past. In designing this new improvement the maker has kept in mind the necessity or desirability of changing old models, which are now in operation, into the new models by furnishing the necessary parts at reasonable prices which can be built into the old models by any mechanic familiar with truck or wagon work.

Compound Gearset Design

THE usual form of three-speed selective gearset used on the majority of passenger automobiles is not satisfactory on heavy duty motor vehicles intended for commercial purposes and there are conditions met with in such service that make even the four-speed gear box that has been provided on a number of trucks inadequate at times. The accompanying illustrations show a transmission used on a new type of truck which provides five forward speeds and two reverse ratios without having any more parts than the ordinary four-speed transmission. It is claimed that with a transmission of this kind under favorable conditions 36 per cent more speed is obtainable without augmenting the engine crankshaft revolutions or consuming more fuel. It is also stated that on the extreme low gear ratio 91 per cent more power can be secured without running the engine at excessive speeds.

The manner in which the added speed ratios are obtained is clearly outlined. It will be observed that a small gear on the primary engine-driven shaft meshes with a large constant mesh gear on the countershaft. Instead of having only one set of constant mesh gears, as is the case in the ordinary three- or four-speed gearset, the design illustrated has really two pairs of constant mesh gears, either one of which may be clutched to the countershaft by a double jaw clutch member. This slides on keys so that it must drive the countershaft regardless of which of the two constant mesh gear members it is clutched to. The higher speeds are obtained when the jaw clutch engages the constant mesh gear on the countershaft that is of practically the same size as that on the main shaft.

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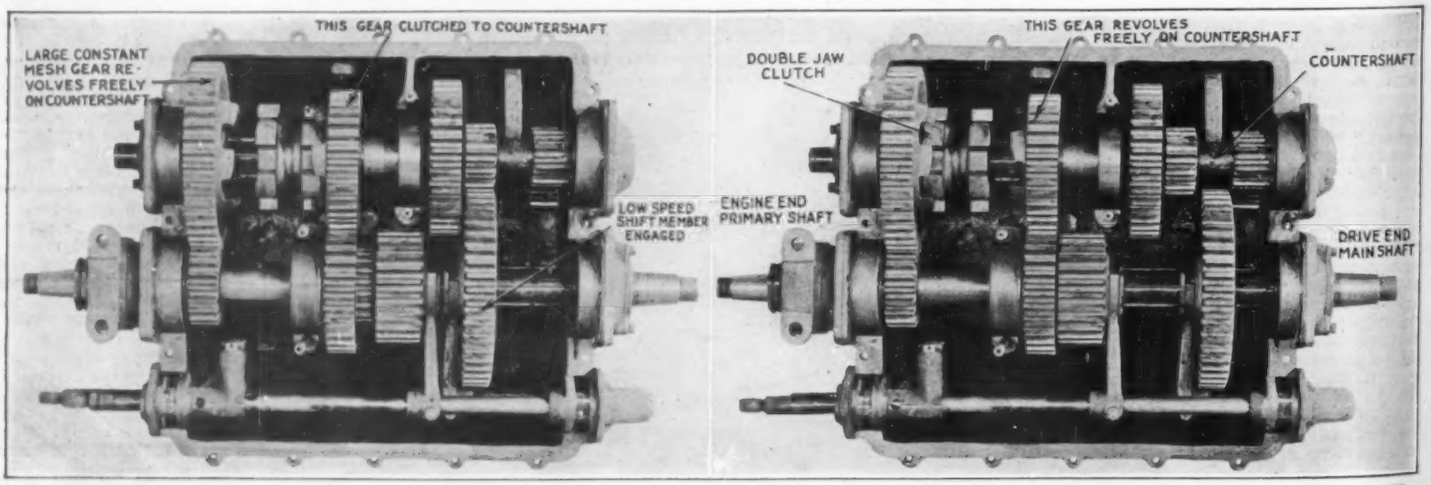

THIS GEAR CLUTCHED TO COUNTERSHAFT
LARGE CONSTANT MESH GEAR REVOLVES FREELY ON COUNTERSHAFT
LOW SPEED SHIFT MEMBER ENGAGED
THIS GEAR REVOLVES FREELY ON COUNTERSHAFT
DOUBLE JAW CLUTCH
COUNTERSHAFT
ENGINE END PRIMARY SHAFT
DRIVE END MAIN SHAFT

Left: **Countershaft in high gear position, low gear shift member engaged with pinion on countershaft. Shifting the double jaw clutch member will provide a much lower gear ratio to cope with unusual operating conditions.** ***Right:*** **Countershaft low gear engaged, but countershaft ineffective. High speed shift member in direct drive position, power transmission direct from engine to drive ends of shafts**

New design of gear box which provides for five forward speeds and two reverse

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AIRPLANE.—J. E. PEARSON, Mimosa, N. C. The purpose of this invention is to provide an airplane having greater plane surface and greater carrying capacity without increasing the weight of the machine. The airplane comprises a fuselage including an inner body of rectangular formation and an outer body of cylindrical formation, a vertical plane arranged along the longitudinal axis of the fuselage, a horizontal plane arranged along the longitudinal axis of the fuselage and disposed at right angles to the vertical plane.

Pertaining to Apparel

NECKTIE.—M. F. WALT, 610 Nebraska St., Huron, S. Dak. An object of this invention is to provide a necktie which will not become wrinkled in service. A further object is to provide a device of this type that can be slidably moved between the wings of a collar, can be readily adjusted, presents a neat appearance, and in which a stick pin may be thrust therethrough to prevent accidental disengagement.

BRASSIERE.—I. PANES, 2107 Mapes Ave., Bronx, N. Y. The invention contemplates the provision of brassieres which may be readily caused to properly fit women of different sizes. An object is to provide a garment which may be easily put on and taken off. A further object is to provide a brassiere which is formed of two independent parts connected together at the upper edge with each part provided with the tie strings for independently tying the sections in place.

Electrical Devices

MAGNETO.—E. A. NEW, address Wm. W. Nicoll, 11 Broadway, New York, N. Y. The invention relates more particularly to hand-operated magnetos designed to discharge a uniform current at each operation and which is particularly adapted for use in blasting operations. A further object is to provide a magneto which is operated by a spring and winding means to store energy therein, and which means are disconnected when the spring has been given a predetermined movement.

Of General Interest

CLOTHES HANGER.—R. G. TYLER, 15 Billingham Ave., West Everett, Mass. An object of the invention is to provide a clothes hanger which may be readily installed in a closet or cupboard and which will be adjustable as to length. A further object is to provide means for attaching the hanger to a support, which means may be folded so as to take up very little space when the hanger is not in use.

LAWN SWING.—G. H. BUGENHAGEN, Weinrebe Bldg., Minot, N. D. An object of the invention is to provide a device in which the carriage of the swing may obtain any desired height in its oscillatory movement without causing the occupants to be brought into contact with the supporting frame. A further object is to provide a swing in which children or other occupants may easily enter and leave the seats, and in which all danger of pinching the hands between the working parts is eliminated.

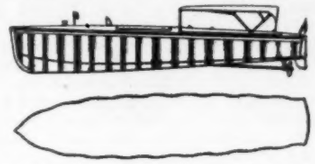
FOLDING CONVERTIBLE GO-CART, HIGH CHAIR AND BABY-JUMPER.—O. H. MEYERS, 530 W. 46th St., New York, N. Y. This invention relates to combination devices, an object being to provide an apparatus which by different positioning of the parts perform the functions for which it is intended. A further object is to provide mechanism which can be easily and quickly manipulated to change the position of arrangement to perform the functions of a baby coach, a high chair and a baby jumper.

COLLAPSIBLE CRATE OR PACKING CASE.—N. J. MCLEOD and C. F. RAINSFORD, Eagle Hotel, Hindley St., Adelaide, South Australia, Australia. This crate has been especially designed for packing, shipping and the transportation of exhibition poultry, or may be used for other purposes, its special feature being that when empty it can be collapsed or folded down into small space for transit or storage, thereby reducing space; consequent cost, and the liability of breakage, when erected the parts interlock and hold one another firm.

SHOESTRING TIP.—A. C. LADD, Creede, Col. An object of this invention is to provide a means for retaining the shoestring in the eyelet of a shoe. A further object is to provide a hooked tip, which may be used with either round or flat shoe laces, and which catches in the upper eyelets of the shoe and enables the rest of the string to be loosened without pulling the ends out of the upper eyelets.

SANITARY TUB AND SINK TRAP.—H. J. MCGUCKIN, 776 9th Ave., New York, N. Y. This invention has for its object to provide a trap which will properly trap one or more fixtures and trap both articles against the passage of gas from the sewer. A more specific object is the provision of a trap to which two or more drain pipes may be connected, the connection for most of the pipes being beneath the level of the water in the trap.

BOAT HULL.—G. GEIST, 1323 Boston Road, New York, N. Y. The object is to prevent a boat-hull structure in which it is possible with



A SIDE VIEW AND HORIZONTAL SECTION

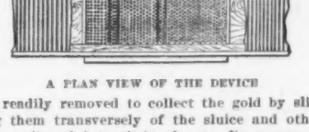
the same horsepower to obtain an increased speed. The boat hull comprises side portions having a plurality of integral, vertically extending wavelike corrugations throughout its length, the corrugations having an amplitude relatively small compared to the wave length.

PLASTER BOARD.—J. J. DOOLEY and T. H. A. HOWLEY, 213 Beach, 118th St., Rockaway Park, L. I., N. Y. The invention has for its object to provide a plaster board arranged to lock or key the plaster in place. Another object is to reinforce the plaster board and at the same time provide a simple means for nailing it to the studding, joists or other support without danger of the nail head pulling through the board in case the latter becomes damp or soft.

FISHHOOK.—A. F. THORSTEIN, c/o Lillian B. Thorstein, 1121 Flatbush Ave., Brooklyn, N. Y. An object of the invention is to so construct a fishhoook that no danger of the same tearing the fish's mouth exists no matter how great the pull. A further object is to provide a construction which shall be extremely simple, its parts being such that it may be manufactured at small expense, at the same time be strong enough to reduce the danger of breakage to a minimum.

DISPENSING CABINET.—W. E. CASSELL, address Lardner & Cannon, 15 Harbison Block, Fort Scott, Kan. Among the objects of the invention is to provide a dispensing cabinet which will be mainly transparent so as to attractively display the goods and which can be operated to dispense the lowermost article in any of the compartments, one at a time: provision is made by which the device can be readily taken apart for cleaning and easily assembled.

CONCENTRATOR.—J. W. POLLOCK, Soldiers Home, Sawtelle, Cal. This invention relates to a construction of riffles and amalgamating trays for use in placer mining. The trays may



A PLAN VIEW OF THE DEVICE

be readily removed to collect the gold by sliding them transversely of the sluice and other trays slipped into their places. By means of this construction a very high percentage of flour gold may be saved as well as the black sand.

NEGOTIABLE PAPER.—C. D. GRATON, 216 Roseville Ave., Newark, N. J. The invention especially relates to checks, drafts, money orders, and the like. Among the objects is to provide a check which is to safeguard the payor against fraudulent methods being carried out to raise or increase the amount originally provided for, and to provide a check which has a wider range than the ordinary travelers' check in that the check may be made travelers check in that the check may be made out for the exact amount of the purchase of goods.

WINDOW.—A. MACKINNON, Tuckahoe, N. Y. The general object of the invention is to provide a window having sliding sashes pivotally connected with suspending chains or cords to permit of the window being turned about the pivots as an axis for convenient cleaning or to provide ventilation to a greater or less degree, a novel form of stop beads and parting strips factoring in the turning of the sash.

SAFETY MATCH TRAY.—A. A. TUBBS, Hotel Charlton, 68 Plummer Ave., Hammond, Ind. The invention is primarily designed to be used for advertising. An object is to provide a holder which may be placed in hotels, restaurants and the like so to afford easy access to the matches and the striking surface while at the same time prevent the liability of the box being carried away.

ATTACHMENT FOR EXTENSION TABLES.—J. O. LARSON, c/o Bierman Furniture Co., Northfield, Minn. The object is to provide an attachment by means of which extension leaves may be added and firmly locked to the table and to each other at one side to prevent any displacement with respect to the top and each other, and wherein the leaves are easily detached when desired.

DAM OR CHECK.—C. L. SYES and S. MITCHELL, Box 531, Ault, Colo. This invention has for its object to provide a device capable of being transported from place to place, and being secured in place in a ditch or drain at any desired point, for forming a check or closure to stop the flow of water, and wherein the said dam or check is provided with means for permitting a restricted flow which may be regulated.

PROCESS OF REDUCING IRON FROM THE ORE.—J. T. JONES, 1104 Mississippi Ave., Dormont, Pa. An object of the invention is to provide a process for reducing iron from the ore without the use of lime, and for recovering the iron in a form which may be more readily handled or shipped. A further object is to provide a process by means of which not only is a smaller amount of fuel needed but a portion of the fuel is recovered in the form of coke of good burning quality.

PROCESS OF PRODUCING FERROSILICON.—J. T. JONES, 1104 Mississippi Ave., Dormont, Pa. An object of the invention is to provide a process for the production of ferrosilicon which does not require the use of specially designed machinery, but which may be carried out through the use of ordinary apparatus such as a regenerative coking oven and a regenerative furnace. This process requires that the ore be in a finely divided state.

METALLURGICAL PROCESS. — J. T. JONES, 1104 Mississippi Ave., Dormont, Pa. This process consists in crushing the ore to a fineness approximating twenty to one hundred mesh, mixing with the crushed ore an excess of crushed coal of substantially the same fineness, heating the ore and coal together substantially out of the presence of air, to a temperature sufficient to coke the coal, and to produce an agglomerated mass resembling coke, and subsequently separating the metals from the coke.

VULCANIZER.—E. D. HOSTLER, I. J. HAMIEL and C. H. MATHER, address Hamiel & Mather, Tipton, Iowa. The invention relates more particularly to a vulcanizer designed for connecting the ends of rubber tubes, an object being to provide a device which facilitates the vulcanizing operation either in the forming of a single or a double splice. A further object is to provide a vulcanizer which is readily adjustable to the size of the tube to be vulcanized.

Hardware and Tools

WRENCH.—G. C. KOTERA, 2318 Cottage Grove Ave., Chicago, Ill. An object of this invention is to provide a wrench which will be capable of quick adjustment and at the same time capable of absolutely accurate adjustment so that it may be adjusted to fit any size nut, without any play in the movable jaw. The wrench is simple and strong.

DENTAL TOOL.—F. GONZALEZ, 155 W. 47th St., New York, N. Y. The invention aims to provide means which will permit the operation of the tool by the same hand which grasps the tool, thus permitting the freedom of the second hand of the operator. A further object is the construction of a device in which any accidental disengagement of the cap from the stem of the chuck will be prevented.

COMBINATION SCRAPER, CHARGER AND TAMPER.—T. J. AVERY, Albia, Iowa. An object of the invention is to provide in one tool means for effectively performing a plurality of functions ordinarily performed by a number of separate tools in blasting operations, such as in coal mines. A further object is to provide a tool that can be used in placing and tamping an explosive charge in position for firing without any possibility of producing a spark.

VALVE SPRING COMPRESSOR AND VALVE GRINDING TOOL.—J. E. O'SULLIVAN, 1027 Park Ave., Madison, Ind. The invention has for its object to provide a simple, inexpensive tool of the character specified by means of which the springs of valves of the overhead and cage type may be compressed easily and uniformly and by means of which the valve may be ground.

Heating and Lighting

OIL BURNER.—J. A. LARSON, Spruce and Van Dine Ave., Glendale, N. Y. The invention aims to provide an oil burner which may be used with extreme economy for commercial and house heating purposes, and by means of which primarily the volatile fluid will be more readily and thoroughly vaporized, further insuring an intimate commingling and minute sub-dividing of the particles forming the fuel mixture.

HEATING SYSTEM.—P. MCLAUGHLIN, 520 Central Ave., Dover, N. H. Among the objects of the invention is to provide a heating system in which the hot air is utilized to vaporize water and direct the moisture laden air together with the direct heat units of the heating means through any approved system for heating purposes, the air being directed by means of a fan or blower into and through the system which results in an economy of fuel and permits an effective control of the circulating medium.

RETORT FOR EXTRACTING OIL, ETC.—A. V. YOUNG, Box 66, De Beque, Colo. The invention relates to the extraction of oil, gas, and other products from shale, oil sand, coal, etc., by destructive distillation, and has for its object to provide a kiln, and process for the extraction from ores and the like. The process consists in heating the material to a sufficient temperature to drive off the gas, oil or the like, and condense the gaseous products driven off.

CLEAN-OUT FOR BURNERS.—E. FOLGMAN, 31 3rd St., Brooklyn, N. Y. This invention relates to self-blowing torches. The primary object is to so construct the plugs or caps closing the ends of the fuel and retort tubes that a passage is presented in alinement with the passage through the constructed burner tube in order to facilitate the cleaning thereof.

Machines and Mechanical Devices

LATHE CHUCK.—H. A. BROOKS, Bainbridge, Ga. The principal object of the invention is to provide a chuck in which the clamps for holding the work may quickly be interchanged for those of other sizes so that work of various sizes may be quickly accommodated. A further object is to provide a chuck made of two sections separably connected by means of a removable clamp, the work clamps being retained within each section of the chuck.

DEVICE FOR OPERATING FREIGHT ELEVATOR HATCH DOORS.—J. E. W. FOGAL and C. L. SULOHUM, c/o Quincy Elevator Gate Co., Quincy, Ill. An object of the invention is to provide a device by means of which a pair of hatch doors, which are normally locked together, may be unlocked from the car of the elevator, one door moving upwardly and the other downwardly simultaneously, both doors starting with a slow movement, gradually being accelerated, and slowing up toward the end of the movement.

PAPER GRIPPING DEVICE.—S. BECKER, 1205 43rd St., Brooklyn, N. Y. This invention relates to an attachment for printing presses. An object is to provide an adjustable paper gripping device, in addition to those already provided, which will prevent paper, throughout the greater portion thereof from rippling or billowing, which provision insures the proper disposition of printing matter on the paper without disfiguration thereof.

ATTACHMENT FOR WOODWORKING SHAPERS.—W. A. HENN, c/o Peerless Tank & Seat Works, Evansville, Ind. An object is to provide an attachment for woodworking shaper

having means for automatically holding the work to be shaped in contact with the cutting knives and for moving the work to occasion the shaping of the same in the manner required. A further object is to provide a device that has means for automatically varying the speed of movement, to compensate for differences in the hardness of different grades of wood when the knife is cutting against, or in the direction of the grain.

PROFILE MAP MACHINE.—E. S. CLARK, Walla Walla, Wash. An object of the invention is to provide a machine to produce automatically a delineation on a record sheet of the profile of the road traversed by the vehicle on which the device is carried. The machine comprises a pendulum mounted to swing on pivots in a vertical plane to the direction of travel, thus indicating the grade. All the parts are mounted in a suitable rigid frame.

PAPER FEED ALARM FOR ADDING MACHINES.—T. P. MARTIN, JR., c/o Stock Yard Natl. Bank, Oklahoma City, Okla. The principal object of the invention is to provide an electrically-operated alarm for an adding machine in which the paper itself acts as an insulator for separating a pair of electrical contacts which, when the end of the paper approaches, are made to sound an alarm to apprise the operator of the need of a renewal of the paper.

WASHING MACHINE.—H. W. WHITE, 837 W. 6th Ave., Emporia, Kan. The object is to provide a washing machine having a sediment collecting means in the form of a hopper bottom and a perforated plate above the bottom for supporting the clothes, together with a detachable receptacle below the bottom and to which the bottom delivers, the bottom having a baffle plate at the point of delivery.

Medical Devices

HOLDER FOR DENTAL X-RAY FILMS.—J. M. MARTIN, 311 Wilson Bldg., Dallas, Tex. Among the objects of the invention is to provide a holder to which the film may be secured with facility, and in a manner to securely hold the film, as well as to provide retaining members so formed as to blanket the minimum area, and thereby expose the maximum area for the clear viewing of the film. The device is arranged for a single picture or two series totaling views of the complete mouth.

Musical Devices

SHARPENER FOR PHONOGRAPH NEEDLES.—G. W. MAYER, 311 Grove St., Brooklyn, N. Y. This invention is arranged to enable the user to quickly and accurately resharpen a used needle or stylus. Another object is to provide a sharpener which can be readily held in the hand and requires no other support. The sharpener is simple, durable in construction and not liable to get easily out of order.

Prime Movers and Their Accessories

PISTON.—C. R. BANDLE, 475 East Ave. 28, Los Angeles, Cal. Among the objects of the invention is to provide a sheet metal piston for internal combustion engines having cast metal bases with flange and groove connection and also provide within the piston a piston head supporting brace with its base portion located against the piston pin bosses, whereby a maximum of strength and union of parts is insured.

GAS PRODUCER.—D. T. SMITH, 40 Woodberry Grove, Finsbury Park, London, N. 4, England. This invention relates to a method of producing gas for supplying internal combustion engines. The object is to provide a producer of relatively light weight, small size and high efficiency, adapted to supply gas to internal combustion engines and the like, capable of adapting itself automatically to varying loads, and provide practically unvarying quality without distillation of the fuel.

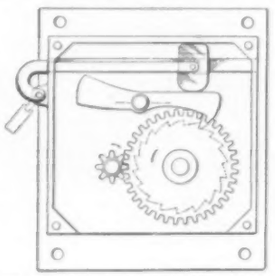
GAS MIXER.—C. H. BENNETT, Ben Wat Corp., 245 W. 47th St., New York, N. Y. This invention relates to internal combustion engines, and has for an object to provide a mixer having means for improving the character of the mixture of gas and air used in an internal combustion engine by causing the small drops of vaporizable liquid ordinarily held in suspension to be broken up and vaporized.

CYLINDER AND PISTON CONSTRUCTION.—O. S. PULLIAM, Park Row Bldg., New York, N. Y. The invention pertains more particularly to devices commonly employed in internal combustion engines. In this invention the cylinders are constructed in such manner as to carry the rings instead of the pistons, thus should the rings break the greatest damage which could be done would be a scoring of the piston; a single piston when it became damaged could be replaced without the necessity of replacing the remainder which go to make up the engine.

Railways and Their Accessories

RAIL JOINT.—J. C. PEPPERS, 700 Jena St., New Orleans, La. The object of the invention is to provide a rail joint of the chair type which is of simple and durable construction, reliable in operation and easy to apply, and which is especially adapted for use as an emergency splice, being capable of effecting a complete and safe union of broken rails without the use of bolts or similar fastenings and with a great saving of time and labor.

CAR BRAKE CONTROLLING MEANS.—C. E. ROCHAMBEAU, 1014 S. 16th St., St. Joseph, Mo. Among the objects of this invention is to provide means for controlling the operation of the drum or winding spindle for



A SIDE ELEVATION WITH FACE PLATE, HAND WHEEL AND CHAIN OMITTED

railway car brake chains. More definitely stated the device provides a positive securing means for the locking pawl cooperating with the ratchet wheel associated with said brake drum.

Pertaining to Recreation

TOY HORSEMOBILE.—R. A. HUNARIAN, San Francisco, Cal. The invention has reference more particularly to a combined hobby horse and vehicle. Among the objects is to provide a device so constructed that the rider will experience realistic conditions in riding the toy, with means whereby the steering wheels may be guided by the reins, and the propelling means being operated through the stirrup straps; both the steering and propelling means being hidden within the body of the vehicle.

GAME APPARATUS.—M. M. SMITH, 357 W. 23rd St., New York, N. Y. An object of the invention is to provide a game affording considerable amusement and requiring skill on the part of the operator to produce desired results. The apparatus comprises a rotatable member having a rim and adapted to contain balls, passages extending from the rim at the lower portion, and receiving pockets at the upper ends of the passages for receiving the balls passing up the passage by centrifugal force, on the rotating of the member.

AMUSEMENT DEVICE.—J. POPPER, 1614 Ave. M., Brooklyn, N. Y. The invention relates to a device so arranged that it may be used as a toy, or in advertising. An object is to provide a reflecting device associated with a movable light in such manner that the moving of the light will cause the reflection to change in proportion to the movement of the light toward or from the reflector.

WAGON.—F. H. WARD, Washington, D. C. Among the objects of the invention is to provide a wagon which may be utilized solely for amusement purposes, and which presents for this purpose a wagon body which may be controlled so as to partake of a wave-like or rolling motion, relatively to the running gear which carries the body thereof.

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Something New in Ferries

(*Continued from page 37*)

electric units is able to function the craft can be run, but at reduced speed. This point is touched upon to bring out that the two engines and their dynamos must be incapacitated before the ferry is out of commission. The boat is intended to accommodate four lines of vehicles on each deck; and her overall length is 205 feet with a maximum beam over the guards of 68½ feet.

An alternative design by the same technicists is for a craft of equal length and breadth but able to transport four lines of machines on the upper deck and six on the main deck. This ferry is to be propelled by bow-and-stern screws actuated by electric motors. The operating current is to be supplied by two Diesel electric units each of 500 horsepower. It is claimed that an automobile ferry of either of these types, compared with a vessel of like capacity driven by a steam engine, could be run for $2,000 less a month.

A still later design, prepared by Messrs. Dickie, is for a double-deck ferry having an overall length of 220 feet and a maximum beam of 64 feet, and is intended to transport at one time anywhere from 80 to 90 automobiles on the main deck. Again, oil-electric drive is to be the propulsive medium operating bow-and-stern-screws, and a speed of 11 knots is expected. The two propellers are to be revolved by independent motors, and when going ahead the after motor will develop 750 horsepower while the forward motor will be running at the rate of 71 horsepower, making a total shaft horsepower of 821. In other words, the bow screw will be rotated only fast enough to neutralize frictional resistance while the after propeller will assume the task of the ferry's drive. There is reason to believe that this arrangement will make for economy, inasmuch as experience has revealed that the forward screw, when operating at full power tends to impede the advance of a vessel so equipped. This is due to the rearward rush of the propeller's wake which augments the frictional resistance to be overcome by the craft.

Probably the most unique scheme for an automotive vehicular ferry is that evolved by Mr. vonRosen. His design calls for a twin hull or catamaran craft having a length of 320 feet with a maximum beam of 130 feet. The spaciousness of the main and upper decks is such that the boat should be able to transport at one time about 320 vehicles, depending upon the size of the machines. With service of a mixed character, consisting of both pleasure cars and motor trucks, the heavier loaded conveyances would occupy the main deck while the lighter cars would be carried on the upper deck. Cabin accommodations would be ample enough to take care of nearly 1,300 passengers.

The two hulls, each with a breadth of 30 feet, are bound together by sturdy girders supporting strong longitudinal beams; and the entire structure is deemed of sufficient rigidity to meet every likely stress with a generous margin of safety. Because the two hulls are of fine model the designer expects to obtain a speed of 14 knots an hour with a total development of 3,000 indicated horsepower. In each hull there would be placed a single reversible Diesel engine of 1,500 horsepower direct connected to shafting reaching fore-and-aft and turning a bow and a stern propeller, respectively. Manifestly, the great beam of the catamaran hulls would insure notable transverse stability; and we are told that a ferry of this character would cost less to build than two smaller boats of similar combined carrying capacity. Undoubtedly, the adoption of Diesel engines would make for operative economy.

The designer has arranged his two decks into a series of alleyways, and this is counted upon to aid in the rapid loading and discharging of the ferry without fear of confusion. Radical as the plan is from that of any existing ferryboats, still the vonRosen craft is of an order that may be looked for in the near future, especially where heavy vehicular traffic must be taken care of. Conditions exist today in some sections of the United States demanding a convenience of this sort. The question is: When will municipal authorities or public enterprise take the situation in hand and build the needful navigable links to bridge the hampering water gaps? Some are badly needed now.

Putting Green Sand to Work

(*Continued from page 40*)

At the New Brunswick plant, the method involves the heating of the sand with ordinary lime and water, which releases the potash from its union with the sand, transforming it into soluble and usable form. Every day 1,000 tons of green sand, 900 tons of quicklime, and 5,100 tons of water will be continuously pumped through large digesters, where the wealth of potash locked up ages ago will be released.

To supply the lime necessary for treating the green sand, pure deposits of limestone will be taken from quarries located in Sussex County, New Jersey. Quarrying and crushing machinery will be installed to supply 1,700 tons per day of crushed limestone, which is to be transported to the New Brunswick factory, a distance of about seventy miles by railroad.

Interesting, indeed, are the methods used in the manufacture of the pure potash for the use of the farmers, the laundries, the soap factories, and of the countless other uses to which potash is put. For the burning of the limestone there has been built the largest lime plant in the world, consisting of ten great kilns, that have every appearance, when viewed from the front, of fourteen-inch guns.

The limestone, crushed from the quarry lumps to a uniform one-inch size, will be discharged from the railroad cars into an unloading hopper which feeds directly to a conveyor belt for carrying the material to small storage bins above the kilns, from which it will be automatically fed into the kilns.

A large crane is used for excess shipments, which are to be dumped and removed to a main storage space of 500 feet long by 150 feet wide and piled for use in time of interrupted shipments.

The hot lime discharged from the kilns will be cooled in rotary coolers and slaked at the end of the cooler with an excess of water, thus forming a lime slurry easily and cheaply transportable by pumps.

Later it will be shown how the residue is used, but mark how every little thing is utilized during the process of manufacture. The lime kilns are to be heated by oil and the waste gases collected and used under waste heat boilers, thus producing enough heat to amount to fifty tons of coal daily.

The green sand, which is excavated from its beds by steam shovels, will reach the plant by barge in a fine, granular sandy condition, and will be unloaded by a giant crane already built. As in the case of the limestone, there is ample storage space to accommodate a supply, and the crane is of sufficient capacity to handle the normal demand of the grinding mills and take care of the storage. The green sand is conveyed to the grinding building where, mixed with water, it is ground so that 90 per cent of it passes through a 200-mesh screen.

The grinding occurs in tube mills. From the mills, pumps elevate the ground green sand pulp to a storage and measuring tanks, and then to mixing tanks where it is mixed with the milk of lime in the proper proportions. The charge having been prepared, the mixture is then sent through the digesters, where the conversion takes place. The "slurry," as it is called, is heated to 470 degrees Fahrenheit, which is the temperature

equivalent to 500 pounds of saturated steam.

To keep the water in the liquid phase, the slurry is put under sufficient pressure to prevent the formation of steam. It will be kept in the digesters a little more than an hour, which has the effect of releasing about three-quarters of the potash contained in the sand, but this is not "captured" until it is evaporated down in the large vacuum pans.

The specific type of digesters that will be used are those developed after long experimentation at the small factory run for the past few years at Jones Point. The factory at Jones Point is called a small one, but it handled 20 tons of green sand a day. The digesters consist of very strong steel cylinders thirty feet high through which the slurry will be continuously pumped day and night, month in and month out. Just before the slurry enters the digester it will be heated hot by the injection of steam under 500 pounds' pressure. The cylinders are chosen of proper size to hold the slurry for an hour or a sufficient time to effect the conversion of three-quarters of the potash in the hot slurry into a very soluble and easily "captured" form.

After leaving the digesters, the hot converted slurry will have its heat removed in special boilers in which the hot liquid is used as the source of heat and thus generates steam for the plant. The excess pressure of the slurry will be removed by friction in small pipes. The slurry, now cooled below the boiling point of water, will be filtered in standard filters and the liquid caustic potash thus obtained sent to the evaporator building for concentration.

In the evaporator building will be located the large quadruple effect evaporator, which is employed to concentrate the caustic potash. This evaporator consists of four sections each as tall as an ordinary three-story house, and it has a capacity of 5,000 tons of water evaporated in each twenty-four hours, utilizing exhaust steam exclusively, and using this steam four separate and distinct times.

Turning back to the residue that was separated by filtration from the caustic potash, useful by-products of the transformation of green sand are found. The excess of the lime and the silicates formed in the reaction are capable of a variety of uses, the most important of which is in the production of brick.

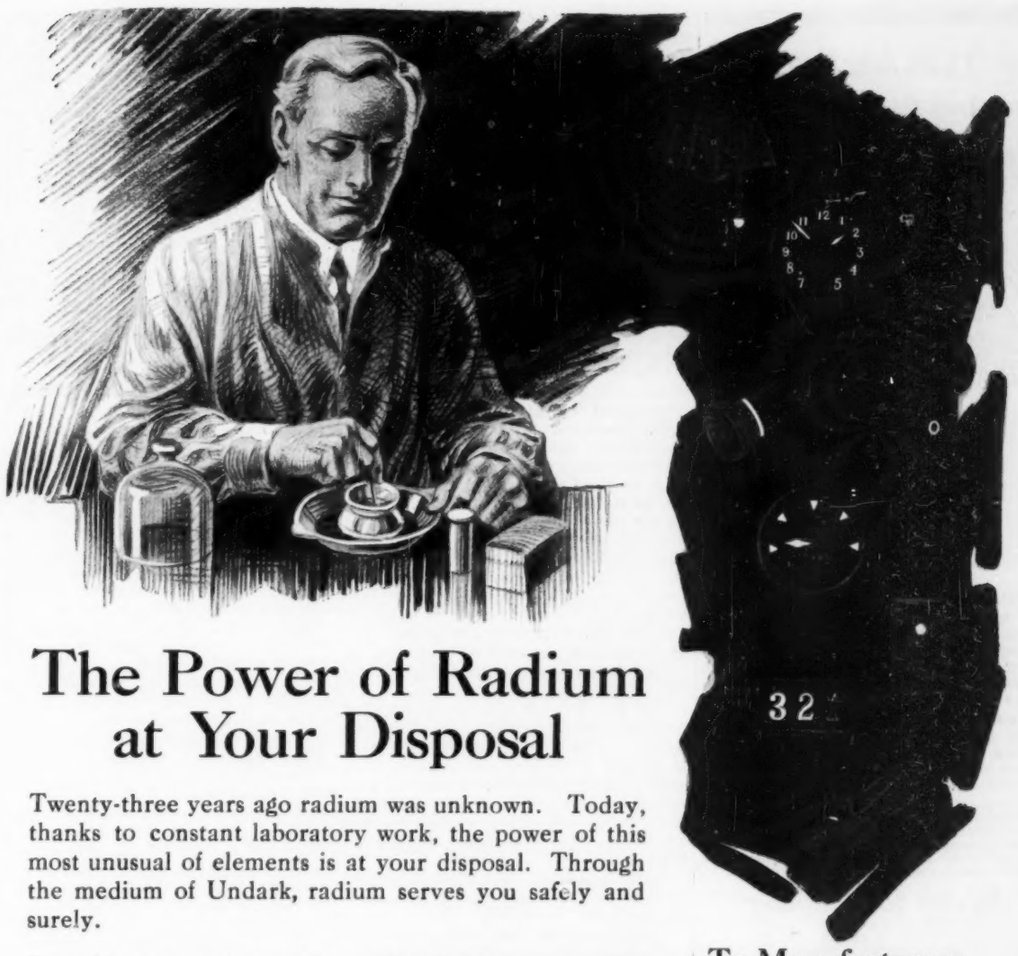
Already, millions of bricks have been made out of the residue. The process is quite simple. The residue is mixed with sand, and the resulting material is pressed into bricks. These bricks are then placed into hardening cylinders, where they are subjected to 150 pounds of steam for some hours to effect the reaction between the cementitious materials of the residue and the sand. These bricks have successfully stood exhaustive tests as to quality, and have been used to build some of the buildings at the New Brunswick plant.

The residue, carrying as it does about 40 per cent of lime together with considerable silica in a very finely divided form, will be marketed where lime is needed for sweetening the sour soils of New York, New Jersey, and Connecticut, as well as other states where the price of transportation is not too great. It is confidently expected that there will be markets for this lime-carrying residue to use 300,000 tons a year. The New Jersey Experiment Station located at New Brunswick also, is using this lime carrying residue on some of its experimental plots, and already its fine properties have been shown.

Our Latest Battleship, the "Maryland"

(*Continued from page 41*)

play the greatest possible stress on all parts of her machinery and equipment; but not the slightest trouble was experienced. In fact, naval officials declared she operated more like a boat that had been in service four or five years, so



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readily and easily did she respond in the tests.

Captain Charles F. Preston, who has been assigned to the command of the "Maryland," and was aboard during the preliminary trials, is most enthusiastic over the perfect performance of the new electrically-driven ship. "Never on a warship that pleased me more in my 36 years with the Navy. She's a wonder in every respect, the best warship in our Navy and the most powerful in the world," he declared; "I am highly pleased and satisfied with her electric equipment. There is practically no vibration and sometimes I actually looked out to see to learn if we were under power, so quietly and smoothly did her machinery operate."

Like her prototype, the "New Mexico," pioneer electric warship of the world, the "Maryland" is electrical throughout. Her main propulsion machinery consists of two Curtis steam turbine generators, each designed to develop 11,000 kilowatts at a speed of 2,630 revolutions per minute to drive the ship 21 knots. These supply power to four 7,000 horsepower General Electric induction motors, directly connected with the four propellers and turning at 170 revolutions per minute. The motors, among the largest ever built, are 12 feet in diameter, weigh 62 tons, and the 28,000 horsepower thus available for propulsion purposes is enough to supply power to a city of 100,000 population.

The two turbine generators, supplied with steam generated by oil-burning boilers, can be run independently. Either is capable of driving the ship up to a speed of about 17 knots. The power generated by them is used for no other purpose than propelling, electrical current for other needs being generated by six 300-kilowatt turbine generators.

Virtually every electrical appliance used afloat and ashore has been installed in this new battleship. The electrical equipment includes radio telegraph, loud speaking telephones, ordinary telephones, gyroscope compass, steering gear, anchor windlass, capstan, boat cranes, winches, air compressors, air heaters, turret training, turret gun elevating, ammunition hoists, gun firing, range signaling, powder testing oven, common deck fans, ice machines, laundry equipment, carpenter shop, lighting, visual signals, motion pictures, sterilizer in operating room, potato peeler, ice cream freezer and other kitchen utensils, bake ovens, irons for laundry and tailor, storage batteries, motor boat ignition, etc.

It is probable that no ship built by any nation in the past has been so thoroughly equipped for the comfort and convenience of the crew.

A completely equipped hospital will be maintained on board with navy surgeons to look after the health of the crew and a dentist to look after the men's teeth. A chaplain will be assigned to the ship to hold regular church services and to devote his time to spiritual welfare of the officers and men.

The "Maryland" is third in order of completion of the electrically-propelled battleships for the navy. She was built by the Newport News Shipbuilding and Dry Dock Company and the electrical equipment was designed and manufactured by the General Electric Company.

The ship was launched on March 20, 1920. Her chief characteristics are:

Length	624 feet
Beam	97½ feet
Draft	30½ feet
Weight	32,000 tons
Speed	21 knots
Number of propellers	4
Shaft horsepower	30,000
Oil capacity	1,400,000 gallons
Oil-burning boilers	8

Three more battleships of this type are being built: the "West Virginia" to be ready for her trial trips in 1922, the "Colorado" and the "Washington." In addition the Navy is building six 43,000-ton, 60,000-horsepower battleships and six battle-cruisers, the latter rated at 180,000 horsepower each, which makes the propelling machinery six times as powerful as that of the "Maryland." Both of these types of warships will carry 16-inch guns will be electrically driven.

Production of the electrical machinery for several of these vessels is now progressing under the direction of W. L. R. Emmet, who advocated the principles of the electric drive as long ago as 1909, was instrumental in its adoption by the Government, and designed the first electric drive installed by the Navy on a battleship, now working so successfully on the U. S. S. "New Mexico."

Something New in Salvaging Equipment

(Continued from page 41)

finally sold to the second salvage concern for $10,000 and the present operation undertaken. While no figures are yet available, it is believed it cost a relatively small sum to raise the vessel this time. It is estimated the wreck is worth about $100,000, besides a valuable cargo of paint.

It is predicted that the new equipment not only greatly reduce the cost of salvaging vessels, but will make possible the salvaging of many vessels which could not hitherto be raised.

The "mole," upon which the new system principally depends, consists of a watertight steel housing for two electric motors, each of which drives independently and in opposite directions a screw propeller of slight pitch and at slow speed. The propellers are in front and a broad steel rudder is located in the rear of the machine. It trails behind it a control cable and a steel lifting cable or chain. By varying the speed of one motor or the other as well as the inclination of the rudder the direction of the machine may be changed at will by the operator while burrowing in sand. In preliminary tests the machine burrowed through dry gravel under good control.

The operator is provided with a complicated control board, with instruments which indicate the exact position of the "mole" at all times. Colored lights indicate whether the machine is on an even keel or not and whether it is traveling up or down. An electrical stethescope is provided and it is claimed that a trained operator can determine, by listening in this, just what is the nature of the bottom through which the "mole" is traveling and can tell at once when an obstruction of any kind is encountered.

It is necessary for a diver to descend with the "mole" to see that it is properly started on its journey under the ship. As soon as the two propeller screws emerge from the bottom on the other side of the wreck, they of course have no traction and the machine has to be hoisted up the rest of the way. The diver must locate the "mole" as it emerges, and to aid him in this the machine is equipped with a tapping device which guides him to it by sound.

Once the lifting cable is passed under the vessel, pontoons are attached to each end; and when a sufficient number of pontoons are ready in place, they are simultaneously pumped full of air and the vessel is lifted from the bottom.

The pontoons deserve special attention. Instead of the conventional wood or metal construction, they are veritable underwater balloons, being constructed along identical lines with an air balloon. The pontoon consists of an inner rubber envelope which is covered with heavy canvas. The whole is enclosed in a heavy mesh bag of ropes to which the lifting cables are attached. An essential feature of the pontoon is a compensating valve which gradually diminishes the air pressure in the bag as the pontoon approaches the surface.

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When the pontoons are used at considerable depths an enormous air pressure is necessary to overcome the great water pressure. But as the pontoon rises the pressure on it diminishes, and unless the internal air pressure were relieved it would be sufficient to burst the bag. Each pontoon is said to have a lifting capacity of 25 tons and it is a simple matter of calculation to determine how many will be required to raise a vessel. It is thought double or triple rows of pontoons would be necessary to raise some of the largest vessels.

The wooden or metal pontoon has always had the disadvantage that it could not be used in high seas because of the danger of damaging both pontoon and wreck by bumping together. It is claimed that the new pontoon, on the contrary, will act as a buffer to protect the wreck after it has been raised and while it is being towed to drydock.

The inventor claims for his devices the ability to work in very deep waters, where salvage operations are now considered impossible. His contention, of course, remains to be proved. The fact that the diver has to do nothing but see that the machine is started right and to hook on a line when it emerges from the other side, will make it possible, it is said, to equip him with one of the rigid types of diving armor which hitherto have been of very little use because they so restricted the movements of the workmen.

If this feature of the device proves practicable, a veritable treasure-mine will be opened to the salvager. In spite of the fact that the vessels raised since the war, especially in European waters, represent an enormous fortune, most of the known sea wrecks lie at depths at which a diver cannot work. The chief advantage of the system appears, however, in the fact that all of the equipment can be carried in a single tug-boat and the fleet of vessels ordinarily required in raising a wreck are dispensed with. The cost of salvaging is materially reduced and the time required is much less, if claims are born out in future and more difficult operations.

How Much Air for the Tunnel?

(*Continued from page 42*)

adjustable openings into continuous expansion chambers on each side of the roadway proper, from which the air will escape into the tunnel. The exhaust duct located above the roadway and connected with the exhaust fans at the shafts will be provided with openings of varying sizes equipped with adjustable shutters as shown in one of the accompanying photographs. By making the openings for the intakes and outlets adjustable, it is possible to regulate the volume of air supplied and withdrawn so as to meet the requirements of the traffic.

More than 115 tests have already been completed at Champaign, Illinois, where the model duct is located. Despite the fact that this midget structure is only 400 feet long, it is of such construction that its various sectors can be made to represent any particular portion of the real duct which the engineers wish. Special stress has been laid on a study of the losses in downshaft elbows as the air wastes are very high in the elbows and bends that connect the fans with the tunnel ducts proper. Similar emphasis has been placed on the study of the outlet ports or expansion chambers along the roadway to ascertain the losses of outlet air from the duct to the roadway. There are 224 of these outlet ports in the experimental duct and special pains have been devoted to the determination of the most satisfactory spacing of these ports from the standpoint of construction and air delivery.

A 300-horsepower, electrically-operated fan is used in this pocket edition of the Hudson River tunnel, this fan producing 105,000 cubic feet of air per cubic inch. Special electrical recording devices are so arranged in the tunnels that readings can be obtained from them which show the exact air pressure at all parts of the tunnel for the duration of the test periods.

There are four observation stations at regular intervals along the length of the tunnel where engineers remain and make readings during the test periods. The apparatus for recording the air pressure readings at various places in the test tunnel centers in these stations. Although this remarkable duct was constructed only for the tests now in operation and will be razed about August 1, 1921, when the experimental work will be completed, it has served a very useful purpose and has been responsible for the practical solution of tunnel ventilation and air friction problems which, otherwise, would have remained intricate enigmas.

The Summer Sneezer

(*Continued from page 45*)

with protein of feathers to cure her, but she is now not only tolerant of birds, but keeps a parrot as a pet! A New York dramatic critic suffered agonies whenever a cat entered the room. His affection took the form of nausea, and he found it impossible to visit his friends who kept cats lest he should be obliged to make a sudden and unexplained exit. His case, too, was complicated by attacks of "hay fever" whenever he came near a horse. Diagnosis in this case was perfectly simple, and a protracted course of treatment with subcutaneous injections of serum prepared from the protein of cat hairs and horse dander effected a permanent cure.

Some of the susceptibilities that give rise to the "hay fever" symptoms are very readily removed by treatment, in most cases. This is especially true when the infection is due to the pollens of plants. One can obtain a diagnosis that identifies the particular pollen to which the patient is susceptible, and the curative treatment does not have to be administered by a physician, after the first prescription, as the protein preparation for immunization or "desensitizing" can be taken by the mouth.

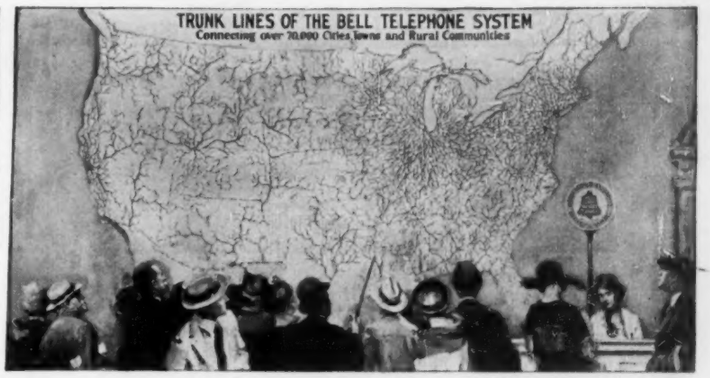
The careful physician today warns the parents and families of persons who cannot tolerate the presence of certain animals or eat certain food that such things are not vain imaginings, whims, fancies or "nerves," but actual illnesses for which a child should not be scolded or laughed at but taken to an up-to-date physician of a modern diagnostic clinic for precise diagnosis and curative treatment. And the hay fever sufferer who goes on suffering year after year has only himself or herself to blame.

Clusters and Nebulae

(*Continued from page 46*)

that they are very numerous, one authority estimating them at 120,000; another puts the number at 500,000. A recent pronouncement of a Lick Observatory authority specializing in nebulæ is to the effect that their great Crossley reflector is able to reveal 700,000, perhaps a round 1,000,000 or more.

Now the spiral nebulæ not only "avoid" the Galaxy, their number increasing roughly as observation passes from low galactic latitudes to high ones, but they seem in fact to be actually in motion away from the galactic plane. They are not only leaving it, but are rushing away. On the other hand, the globular clusters are hastening toward it. The concentration of the one class near the pole or poles and of the other class near the equator appears to suggest that the movements are far advanced. These results appear to be facts. If they are really thoroughly confirmed by future investigation and the exceptions reconciled with them, then these facts will assume remarkable importance. On the surface, they are large conceptions. Hidden back of them must be truths of enormous significance.



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Man-Made Precious Stones

(Continued from page 48)

sure. In principle, his process consists of dissolving the carbon in iron brought to a temperature of about 3,000 deg. in an electric oven, then in cooling this solution quickly by plunging the crucible which holds it in water, melted lead or mercury. The outside surface of the mass, the first to solidify, becomes a rigid prison in which the cast iron, still liquid, cannot expand and will thus be submitted to great pressure. Liquid cast iron possesses the property of increasing in volume as it solidifies. The carbon, finding its space limited, instead of taking the form of graphite, as it does in iron melted in huge furnaces, crystallizes and becomes a substance like the diamond, with a much stronger density. The diamond made in this way is then separated from the surrounding crust by the application of hydrochloric, sulfuric and nitric acids.

In order to attain the high temperature necessary for this process, Moissan invented a special electric oven. This oven consists of two huge blocks of quick lime or magnesia, standing on end, but so arranged that they can be laid one over the other. The lower brick has a longitudinal groove in which two electrodes are placed. Above the huge electric arc lamp which these electrodes make is a crucible in which the substances are placed. When the heavy electrodes are brought together, the arc flashes on with an impressive noise. Long flames escape at the sides, throwing out blinding light. An enormous quantity of electricity is transformed into heat. The functioning of this furnace costs not less than four or five francs a minute; so that the diamond produced in the laboratory costs very much more than the natural gem. For this reason the manufactured diamond is not popular.

Needless to say, it is a far cry from a laboratory experiment to an industrial product. So long as precious stones are obtained more easily and at less expense from mines than from chemists' crucibles and electric furnaces, their manufacture will not become a thriving commercial industry.

Compound Gearset Design

(Continued from page 50)

If the clutch member is shifted so that it engages projections on the face of the larger gear the lower speed will be secured on account of the great difference in diameter of the driving pinion on the primary shaft and the driven gear on the countershaft. Two shift members are provided on the main shaft, the larger one of these giving the reverse ratio and the low speed, while the other one will give the second speed or direct drive just as in the usual three-spread transmission. For example, if the positive clutch is shifted over toward the rear end of the transmission until it engages the smallest of the two countershaft driving constant mesh gears the ratios ordinarily provided by a gear box of conventional design are obtained, *i.e.*, three forward speeds and one reverse depending on the location of the shifting gears on the main shaft.

In the illustration showing the smaller countershaft driving gear clutched to it, the large shifting member on the main shaft is engaged with the small pinion on the countershaft that provides the slow speed ratio. If these gears are left in the position shown, and the jaw clutch member is shifted to the other extreme so that the large constant mesh gear is clutched to the countershaft we still have a low speed ratio but one that is considerably lower than that previously obtained on account of the primary reduction in speed obtainable by the differing diameters of the constant mesh gears then employed. In the illustration showing the high speed and intermediate shift member engaged with the projecting teeth on the face of the larger of the constant mesh primary shaft driving gears the jaw clutch on the countershaft is depicted in engagement with the large countershaft driven gear. When in this position we obtain a direct drive because it makes no difference under these conditions which of the countershaft gears is engaged by the positive jaw clutch. The drive is direct from the engine end to the drive end of the main shaft because the primary or spigot shaft is clutched to the extension of the main shaft of which it forms a part. On the lower gear ratios however, and when the reverse gears are engaged, it makes considerable difference in the speed reduction if one or the other of the constant mesh gears mounted on the countershaft is clutched to that member because on the lower speed and reverse ratios the countershaft comes in to use. Unless clutched to the countershaft by the jaw clutch, the constant mesh members revolve independently of it.

NEW BOOKS, ETC.

A LABORATORY MANUAL OF ANTHROPOMETRY. By Harris H. Wilder, Ph.D. Philadelphia: P. Blakiston's Son and Co., 1920. 8vo.; 193 pp.; 43 illustrations.

Simplified and revised from the author's working rules in manuscript, this manual contains the adopted prescriptions of the International Congress of Anthropologists, with the enumeration of instruments, and a description of the mathematical methods in general use. Footnotes guide the student to the important sources upon which the book is based. Part I. treats of the measurement of bones, including the skull; Part II. of the measurement of the body. Measurements of Indian skulls, and bodily measurements of female college students are tabulated in appendices.

LABOR'S CRISIS. By Sigmund Mendelsohn. New York: The Macmillan Company, 1920. 12mo.; 171 pp.

An employer here gives his views of the problems of labor which, as he remarks, now concern the welfare of society more than of labor. The chief problem has shifted from that of adequate wage to that of inflated wage, and from an oppressed suffering class to a militant one striving for economic dominance. He admits that the situation is intensified by the employer himself. He advocates deep study of these questions at close range. The work is a level-minded presentation of both sides of the shield, and is worthy of a wide reading.

CHEMISTRY AND CIVILIZATION. By Allerton S. Cushman, A.M., Ph.D. Boston: Richard G. Badger, 1920. 8vo.; 151 pp.; illustrated.

Dr. Cushman, for ten years in charge of research work in the U. S. Department of Agriculture and later in charge of the manufacture of explosives at Frankford Arsenal, has treated his present subject in a striking manner. Using the history of chemistry as a background, he builds up scientific achievement as an edifice devoted to the progress and welfare of humanity. He has so written that the general reader as well as the student of chemistry may find edification in the narrative.

LABORATORY EXPERIMENTS IN ORGANIC CHEMISTRY. By E. P. Cook, A.M. Philadelphia: P. Blakiston's Son and Company, 1920. 12mo.; 83 pp.; illustrated.

Designed especially for use with Stoddard's "Introduction to Organic Chemistry," this text, now in a second edition, presents experiments for a first course that illustrate and emphasize important methods of preparation of organic compounds, show typical reactions for each class, and instruct the student in the details of laboratory work. The course has been followed with success in Professor Cook's classes at Smith College.

AMERICAN RURAL HIGHWAYS. By T. R. Agg, C.E. New York: McGraw-Hill Book Company, 1920. 8vo.; 139 pp.; illustrated.

"American Rural Highways" assumes familiarity with drawing and surveying, and provides a good short course for agricultural engineers and students of agriculture. The relationship of highway improvement to national progress is made clear, and the problems of highway administration are set forth, with accepted methods of design and construction, so that the student is familiarized with the distinguishing characteristics and relative serviceability of the common types of road surface.

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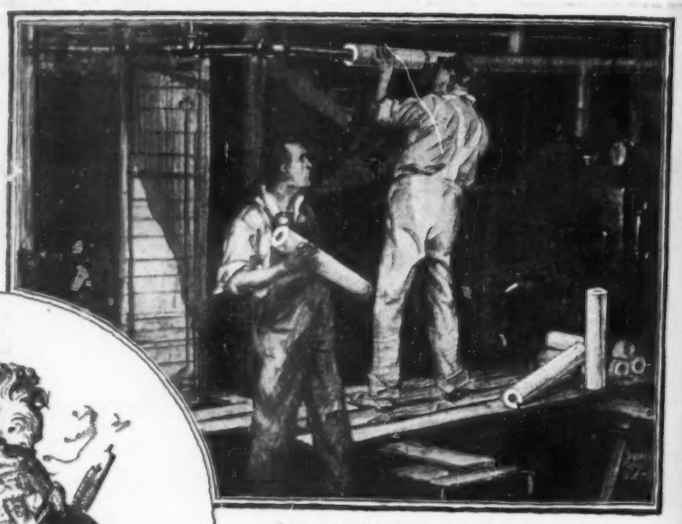

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